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Calculation of Potential Natural Ventilation Airflows and Pressure Differential

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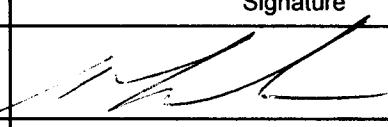
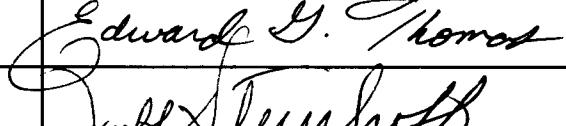
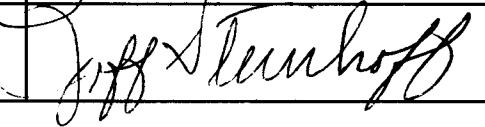
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1. PURPOSE

The objective of this document is to calculate the potential of natural ventilation airflows and pressure differentials. The basis of these calculations will be limited to the 70,000 MTU Layout for Site Recommendation (SR)(CRWMS M&O 2000a, Section 6.3).

This calculation is being prepared in support of the natural ventilation parametric study currently under development by the Systems Engineering organization. This work has been completed in accordance with the technical work plan (CRWMS M&O 2000b) and AP-3.12Q, *Calculations*.

2. METHOD

This calculation uses an iterative analytical method to predict the natural ventilation potential of the Subsurface Facility. Details on the approach used in the calculation are provided in Section 5. The Imperial system will be used for the head pressure calculation because the pressure and psychometric tables from the source documents are provided in Imperial units. The airflow rate and resistance will be calculated using the Imperial system because the inputs from *Design Feature 7: Continuous Preclosure Ventilation* (CRWMS M&O 1999a) were in Imperial units. The final airflow rates will be converted to metric to be consistent with the heat transfer calculations.

The control of electronic management of information was completed in accordance with the technical work plan (CRWMS M&O 2000b, Section 10), that stated that no special controls were required.

3. ASSUMPTIONS

This section provides a list of the assumptions used to perform the calculation. The rationale for each assumption and sections where each assumption is used in the calculation are also identified. For frequently used assumptions, the comment “used throughout” has been substituted for a list of sections.

3.1 LAYOUT DIVISION

To calculate the pressure due to natural ventilation, the SR repository layout (CRWMS M&O 2000a, Section 6.3) was divided into three panels. Panel 1 consists of Exhaust Shaft 1, Intake Shaft 1 and emplacement drifts 1 to 17. Panel 2 consists of Exhaust Shaft 2, Intake Shaft 2 and emplacement drifts 18 to 35. Panel 3 consists of Exhaust Shaft 3, Intake Shaft 3 and emplacement drifts 36 to 51. It is assumed that Panel 1 is representative of all three panels since there are a similar number of shafts, drifts and opening sizes assigned to each. Panel 1 will be used for the calculation as the typical panel. Any changes in the panels or the layout will affect the calculation and therefore this assumption is considered TBV. This assumption is used throughout.

3.2 AIRWAY RESISTANCE

The airway resistance for Panel 1 is assumed the same as the average resistance across the two center exhaust shafts from system B in *Design Feature 7: Continuous Preclosure Ventilation* (CRWMS M&O 1999a, p.30). The average resistance is 5.85×10^{-12} inches x minutes² per feet⁶ (in·min²/ft⁶) as calculated in Attachment I. The basis for this assumption is that the center exhaust shafts from system B in *Design Feature 7: Continuous Preclosure Ventilation* (CRWMS M&O 1999a, p. 30) cover the same approximate area and have approximately the same drift lengths and sizes as Panel 1 and therefore would have approximately the same resistance. Any change in the resistance would produce a change in the calculation, therefore this assumption is considered TBV. This assumption is used in Section 5.1, Attachment I, and Attachment II.

3.3 SURFACE WEATHER

It is assumed that the surface climatological summaries for Panel 1 are the same as the Radiological and Environmental Field Programs Department (R/EFPD) Site 2 (Yucca Mountain) as documented in *Engineering Design Climatology and Regional Meteorological Conditions Report* (CRWMS M&O 1997, p. A-4). The basis for this assumption is that this site, labeled, as Yucca Mountain is the closest site to Panel 1. Any change in the surface climatological summaries would produce a change in the calculation, therefore this assumption is considered TBV. This assumption is used throughout.

3.4 WATER VAPOR

It is assumed that the air will not absorb water vapor while it flows through the repository. This assumption will maintain a constant vapor pressure, in order to simplify the calculations. Any change in the water vapor content would produce a change in the calculation, therefore this assumption is considered TBV. This assumption is used in Section 5.2.3 and Attachment II.

3.5 EMPLACEMENT DRIFT EXHAUST TEMPERATURES

It is assumed that the emplacement drift exhaust air temperatures will be 43, 47, 50, 60, and 70 degrees C. The basis of this assumption is to provide a range of potential closure periods and thermal loading factors, since variations in these parameters will produce different emplacement drift exhaust temperatures. Any change in the emplacement drift exhaust air temperature would produce a change in the calculation, therefore this assumption is considered TBV. This assumption is used throughout.

3.6 AIR TEMPERATURES ON THE DOWNCAST SIDE OF THE REPOSITORY

It is assumed that the vertical column of air between the intake shaft station and the exhaust shaft station will be the same temperature as the emplacement drift exhaust air. The basis of this assumption is that the exhaust raise represents the majority of this air column and the temperature in the raise will be approximately the same as the emplacement drift exhaust air temperature. Any change in the air temperature between the shaft stations would produce a

change in the calculation, therefore this assumption is considered TBV. This assumption is used in Section 5.2.4.1, Section 5.2.4.2, and Attachment II.

3.7 AVERAGE AIRWAY DISTANCES

It is assumed that the average length of the exhaust main and the exhaust shaft connectors is the total distance that the entire airflow travels for the heat transfer calculation. The basis of this assumption is to simplify the overall calculation by reducing the number of iterations required. Any change in the airway distances would produce a change in the calculation, therefore this assumption is considered TBV. This assumption is used in Section 5.4 and Attachment II.

3.8 INSITU ROCK TEMPERATURES

The average rock temperature at the intake shaft collar is assumed to be 18.7 °C. The thermal gradient in the rock is assumed as 0.020°C/m for depth 0 to 150 meters, 0.018°C/m for depth 150 to 400 meters, 0.030°C/m for depth 400 to 536 meters. This assumption is based on the temperature profile in borehole USW G-4 (Sass et al. 1988, p 48, and Figure 1-12), which is located in the area of Panel 1. Any change in the insitu rock temperatures would produce a change in the calculation, therefore this assumption is considered TBV. This assumption is used in Section 5.3.1

4. USE OF COMPUTER SOFTWARE AND MODELS

The VULCAN software product, Version 3.4 (CRWMS M&O 1999aa) was used to extract information from the electronic file for the 70,000 MTU Layout for SR (CRWMS M&O 2000c). This software is a geology and mine engineering computer design system developed by Maptek. The VULCAN V3.4 software is installed on a Silicon Graphics Octane workstation running the IRIX 6.5 operating system (CPU identifier CRWMS M&O #116980).

Based on a special dispensation granted by the U.S. Department of Energy (DOE) Project Operations Review Board, some software that is required to support SR products may be used prior to full qualification. The requirements of this special dispensation are detailed in procedure AP-SI.1Q, *Software Management*, Section 5.11. Qualification of the VULCAN V3.4 software product was in process at the start of this report, but because of the size and complexity of the software system; the necessary qualification could not be completed in time. Therefore, since this calculation will support the SR (CRWMS M&O 2000b, Addendum A, p. A-2), the Interim Use of Unqualified Software to Support SR Products, Section 5.11 of AP-SI.1Q, was used to control the use of the VULCAN V3.4 software.

In accordance with AP-SI.1Q, Section 5.11, a Software Activity Plan was developed for the VULCAN V3.4 software. The VULCAN V3.4 software is controlled by Software Configuration Management under Software Activity Number LV-1999-001 (VULCAN V3.4), (CRWMS M&O 1999aa) and Software Tracking Number 10044-3.4-00 (CRWMS M&O 1999aa). The software was released under a Software User Request and installed on the above-identified workstation. The VULCAN V3.4 software and the technical products developed from it are designated as TBV.

The VULCAN V3.4 software was selected to satisfy the geology and mine modeling needs of the Subsurface Facilities Department as documented in the Software Activity Plan. The software is appropriate for the intended use in this report. After the VULCAN V3.4 software is qualified and baselined in accordance with procedure AP-SI.1Q, the extracted information used in this calculation will be compared with the same information extracted with the qualified software to determine any impacts to this calculation and to remove the TBV status of the VULCAN V3.4 results.

5. CALCULATION

For this calculation the SR layout has been divided into three panels. This calculation deals exclusively with Panel 1 only (see Assumption 3.1).

To calculate the potential of natural ventilation airflows and pressure differentials, a series of calculations are required. Natural ventilation is dependent on temperature differential and column height (Section 5.2 and 5.2.1). To determine the temperature differential the average temperatures for each air column must be determined (Section 5.2.4, 5.2.4.1 and 5.2.4.2). To calculate these temperatures, the heat transferred from the air to the rock or from the rock to the air (Section 5.3) must be considered, as well as any temperature change due to auto compression (Section 5.2.5). Heat transfer is dependent on airflow (Section 5.3), two airflows are estimated to bound the calculation (Section 5.3.6). Using these estimated airflows along with inputs such as air properties (Section 5.3.5) and the intake temperatures, a range of exhaust temperatures can be established. These exhaust temperatures are used, along with the difference in temperature due to autocompression (Section 5.2.5) and the intake temperatures, to determine the average temperatures in each column. These average temperatures along with the barometric pressure (Section 5.2.2) and vapor pressure (Section 5.2.3), which are both derived from inputs using elevation, relative humidity and temperature, are used to determine the specific weight of the column of air. The specific weights of the columns of air and the heights of the columns are then used to calculate the natural ventilation head (Section 5.2). The airflow can then be calculated using the head and the airway resistance (Section 5.1). If this calculated airflow is between the two estimated airflows the calculation is considered bounded.

The actual calculations of specific weights of the columns of air, airflow rates and head due to natural ventilation are located in Attachment II. All the calculations related to heat transfer are located in Attachments III, IV, V and VI. The average intake shaft temperature for Attachment II is calculated in Attachment III, the average exhaust shaft temperature for Attachment II is calculated in Attachment VI. The intake air temperature for attachment VI is calculated in Attachment V. The intake air temperature for attachment V is calculated in Attachment IV.

Sample hand calculations for heat transfer, linear interpolation of air properties and barometric pressure, specific weights of the column of air, airflow rates and head due to natural ventilation are found in Attachment VIII.

5.1 AIRFLOW QUANTITY AND RESISTANCE

The airflow quantity due to natural ventilation is determined by the equation derived from *Mine Ventilation and Air Conditioning* (Hartman et al. 1997, Equation 7.7, p. 242):

$$Q = (h/r)^{1/2} \quad (\text{Equation 1})$$

Where Q = airflow rate in cubic feet per minute (ft^3 / min).

h = head due to natural ventilation in inches of water (in. wg).

r = airway resistance in in. $\text{min}^2 / \text{ft}^6$.

The equations for calculating the head due to natural ventilation (h) are found in Section 5.2.

The calculations of the airflow rates for Panel 1 are found in Attachment II.

Airway resistance can be calculated by rearranging Equation 1:

$$r = h/Q^2 \quad (\text{Equation 1a})$$

The airway resistance for Panel 1 is based on Assumption 3.2, that it is the average resistance across the two center exhaust shafts from system B in *Design Feature 7: Continuous Preclosure Ventilation* (CRWMS M&O 1999a, p. 30). The calculation of resistance for Panel 1 is found in Attachment I.

5.2 NATURAL VENTILATION PRESSURE

The head due to natural ventilation (h) in in. of water, is derived from the equation from *Mine Ventilation and Air Conditioning* (Hartman et al. 1997, Equation 8.3, p. 297):

$$h = L(W_d - W_u)/5.2 \quad (\text{Equation 2})$$

This equation was selected by the author and is suitable for these calculations. This equation can be expressed as:

$$h = LW_d/5.2 - LW_u/5.2 \quad (\text{Equation 2a})$$

Where L = height of the column of air in feet (ft).

W_d = average specific weight of the downcast column of air in pounds per feet^3 (lb / ft^3).

W_u = average specific weight of the upcast column of air in lb / ft^3 .

The downcast air column consists of the column of air between the collars of the exhaust and intake shafts, the intake shaft and the exhaust raise. The upcast air column consists only of the exhaust shaft. The relationship between these air columns is illustrated in Figure 1.

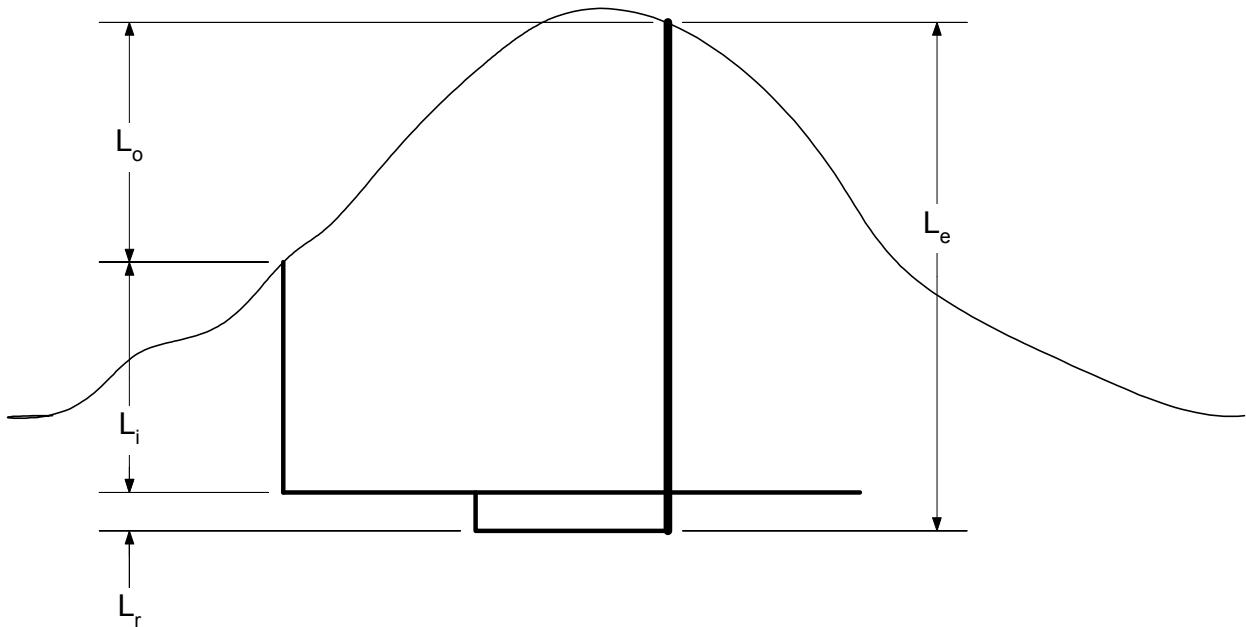


Figure 1. Conceptual Arrangement of Air Columns

Therefore:

$$L = L_e + L_i + L_r \quad (\text{Equation 3})$$

Where L_o = height of the column of air between the collar of the intake and the collar of the exhaust shaft in feet (ft).

L_i = height of the column of air in the intake shaft in feet (ft).

L_r = height of the column of air between the intake shaft station and the exhaust shaft station in feet (ft).

L_e = height of the column of air in the exhaust shaft in feet (ft).

The height of each column is calculated from the difference in elevations, which have been extracted from the *Subsurface Facility Planning Layout in Support of ANL-SFS-MG-000001, REV 00* (CRWMS M&O 2000c) using VULCAN V3.4 and rounded to the closest meter. The elevations have been converted to Imperial units, using a conversion factor of 3.2808 ft/m (Section 5.5.) and rounded to two decimal places. The rounding of the elevations does not affect the accuracy of the calculation.

The inputs as extracted by VULCAN V3.4 are:

	Elevation (m)	Elevation (ft)
Intake Shaft Collar	1430	4691.54
Intake Shaft Station	1044	3425.16
Exhaust Shaft Collar	1460	4789.97
Exhaust Shaft Station	1013	3323.45

L_o = height of the column of air between the collar of the intake and the collar of the exhaust shaft (surface) in feet (ft).
= 4789.97 - 4691.54
= 98.43 ft.

L_i = height of the column of air in the intake shaft in feet (ft).
= 4691.54 - 3425.16
= 1266.38 ft.

L_r = height of the column of air between the intake shaft station and the exhaust shaft station (repository level) in feet (ft).
= 3425.16 - 3323.45
= 101.71 ft.

L_e = height of the column of air in the exhaust shaft in feet (ft).
= 4789.97 - 3323.45
= 1466.52 ft.

To calculate the average elevation of each column the two elevations are added together and divided by two.

The average elevation of the column of air between the collar of the intake and the collar of the exhaust shaft (surface) in feet (ft) is:

Average Elevation = (Intake Shaft Collar Elevation + Exhaust Shaft Collar Elevation) / 2
= (4789.97 + 4691.54) / 2
= 4740.76 ft

The average elevation of the column of air in the intake shaft in feet (ft) is:

Average Elevation = (Intake Shaft Collar Elevation + Intake Shaft Station Elevation) / 2
= (4691.54 + 3425.16) / 2
= 4058.35 ft

The average elevation of the column of air between the intake shaft station and the exhaust shaft station (repository level) in feet (ft) is:

Average Elevation = (Intake Shaft Station Elevation + Exhaust Shaft Station Elevation) / 2
= (3425.16 + 3323.45) / 2
= 3374.31 ft

The average elevation of the column of air in the exhaust shaft in feet (ft) is:

Average Elevation = (Exhaust Shaft Collar Elevation + Exhaust Shaft Station Elevation) / 2
= (4789.97 - 3323.45) / 2

$$= 4056.71 \text{ ft}$$

The average specific weight of the downcast cast column of air (W_d) is:

$$W_d = (L_o W_o + L_i W_i + L_r W_r) / L \quad (\text{Equation 4})$$

Where W_o = specific weight of the column of air between the collar of the intake and the collar of the exhaust shaft in lb/ft³.

W_i = specific weight of the column of air in the intake shaft in lb/ft³.

W_r = specific weight of the column of air in the exhaust raise in lb/ft³.

The average specific weight of the upcast cast column of air (W_u) is:

$$W_u = W_e \quad (\text{Equation 5})$$

Where W_e = specific weight of the column of air in the exhaust shaft in lb/ft³.

Therefore by substituting Equations 3, 4, and 5 in Equation 2a, the head due to natural ventilation (h) is:

$$h = (L_o W_o + L_i W_i + L_r W_r) / 5.2 - L_e W_e / 5.2 \quad (\text{Equation 2c})$$

The equation for calculating the specific weight of a column of air (W) is found in Section 5.2.1.

The calculations of head due to natural ventilation for Panel 1 are found in Attachment II.

5.2.1 Specific Weight of a Column of Air

The specific weight of a column of air (W) is calculated from the equation in *Mine Ventilation and Air Conditioning* (Hartman et al. 1997, Equation 2.9, p. 16):

$$W = (1.325/T_d) x (p_b - 0.378p_v) \quad (\text{Equation 6})$$

Where T_d = average absolute dry bulb temperature for the column of air (°R).

p_b = average barometric pressure in inches of mercury (in. Hg).

p_v = vapor pressure (in. Hg).

The description of how the average absolute dry bulb temperature (T_d) is determined is found in Section 5.2.4.

The description of how the average barometric pressure (p_b) is determined is located in Section 5.2.2.

The equation for calculating the vapor pressure (p_v) is located in Section 5.2.3.

The calculations of specific weight of each column of air for Panel 1 are found in Attachment II.

5.2.2 Average Barometric Pressure

The average barometric pressure is determined using the average elevation of the column and is derived from linear interpolation from the barometric pressure table in *Mine Ventilation and Air Conditioning* (Hartman et al. 1997, p. 663). The average elevation of the column is determined by averaging the elevations that have been extracted from the *Subsurface Facility Planning Layout in Support of ANL-SFS-MG-000001, REV 00* (CRWMS M&O 2000c) using VULCAN V3.4, as outlined in Section 5.2.

The calculations of the average barometric pressures for Panel 1 are found in Attachment VII.

5.2.3 Vapor Pressure

The vapor pressure (p_v) is calculated from the equation in *Mine Ventilation and Air Conditioning* (Hartman et al. 1997, Equation 2.4, p. 15):

$$p_v = rh \times p_s / 100\% \quad (\text{Equation 7})$$

Where rh = relative humidity in percent (%)
 = $(30.7\% + 27.9\% + 22.0\% + 27.0\%) / 4$
 = 26.9% Average relative humidity calculated based on annual summaries (CRWMS M&O 1997, p. A-4).

p_s = saturation pressure in Hg and is taken from the nearest whole temperature value on the psychometric tables in *Mine Ventilation and Air Conditioning* (Hartman et al. 1997, pp. 664 to 669).

The vapor pressure is based on Assumption 3.4, which assumes the air will not absorb water vapor while it flows through the repository.

The vapor pressure for Panel 1 for the surface temperatures of 5.6 °C, 15.7 °C, 27.1 °C (Section 5.2.4.1) are:

At 5.6 °C

$$^{\circ}\text{F} = 9/5 \ ^{\circ}\text{C} + 32 \quad (\text{Section 5.5})$$

$$^{\circ}\text{F} = 9/5 (5.6) + 32$$

$$^{\circ}\text{F} = 42 \ ^{\circ} \text{ (rounded)}$$

$p_s = 0.2676 \text{ in. Hg}$. Based on temperature of 42 °F (Hartman et al. 1997, p. 665).

$$p_v = rh \times p_s / 100\%$$

$$p_v = 26.9 \times 0.2676 / 100\%$$

$$p_v = 0.07 \text{ in. Hg}$$
.

At 15.7 °C

$$^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32 \text{ (Section 5.5)}$$

$$^{\circ}\text{F} = 9/5 (15.7) + 32$$

$$^{\circ}\text{F} = 60 \, ^{\circ} \text{ (rounded)}$$

$p_s = 0.5216 \text{ in. Hg}$. Based on temperature of 60 °F (Hartman et al. 1997, p. 666).

$$p_v = rh \times p_s / 100\%$$

$$p_v = 26.9 \times 0.5216 / 100\%$$

$$p_v = 0.14 \text{ in. Hg.}$$

At 27.1 °C

$$^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32 \text{ (Section 5.5)}$$

$$^{\circ}\text{F} = 9/5 (27.1) + 32$$

$$^{\circ}\text{F} = 81 \, ^{\circ} \text{ (rounded)}$$

$p_s = 1.0665 \text{ in. Hg}$. Based on temperature of 81 °F (Hartman et al. 1997, p. 667).

$$p_v = rh \times p_s / 100\%$$

$$p_v = 26.9 \times 1.0665 / 100\%$$

$$p_v = 0.29 \text{ in. Hg.}$$

5.2.4 Average Absolute Dry Bulb Temperature

The average absolute dry bulb temperature is determined by averaging the intake and exhaust temperatures of each column.

The average absolute dry bulb temperatures are calculated for surface, the intake shaft, the exhaust shaft and the vertical column of air between the intake and exhaust shaft (repository level). Descriptions of how the average absolute dry bulb temperatures for the downcast and upcast columns are determined are located in Sections 5.2.4.1 and 5.2.4.2.

The calculations of the average absolute dry bulb temperature are located:

The intake shaft column of air in Attachment III.

The exhaust shaft column of air in Attachment VI.

The column of air between the intake shaft station and the exhaust shaft station (repository level) in Section 5.2.4.1.

The column of air between the collar of the intake and the collar of the exhaust shaft (surface) in Section 5.2.4.1.

5.2.4.1 Downcast Side

The average temperature for the column of air between the collar of the intake and the collar of the exhaust shaft will be the outside temperature.

The average temperature for the column of air in the intake shaft is calculated where the intake temperature is the outside temperature and where the exhaust temperature is based on the heat transfer between the air and the rock within the shaft, and the change in temperature due to autocompression of the air column. The equations for calculating the exhaust temperatures based on the heat transfer between the air and the rock are found in Section 5.3. The equation for calculating the autocompression of the air column is found in Section 5.2.5.

The average temperature for the column of air between the intake shaft station and the exhaust shaft station will be the emplacement drift exhaust air temperature based on Assumption 3.6. The emplacement drift exhaust air temperatures are 43 °C, 47 °C, 50 °C, 60 °C, and 70 °C, based on Assumption 3.5. To convert these temperatures the conversion factors in Section 5.5 are used:

43 °C

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 43 \\ &= 316.16 \end{aligned}$$

$$\begin{aligned} {}^{\circ}\text{R} &= 9/5 {}^{\circ}\text{K} \\ &= 9/5 \times 316.16 \\ &= 569.09 \end{aligned}$$

47 °C

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 47 \\ &= 320.16 \end{aligned}$$

$$\begin{aligned} {}^{\circ}\text{R} &= 9/5 {}^{\circ}\text{K} \\ &= 9/5 \times 320.16 \\ &= 576.29 \end{aligned}$$

50 °C

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 50 \\ &= 323.16 \end{aligned}$$

$$\begin{aligned} {}^{\circ}\text{R} &= 9/5 {}^{\circ}\text{K} \\ &= 9/5 \times 323.16 \end{aligned}$$

$$= 581.69$$

60 °C

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 60 \\ &= 333.16 \end{aligned}$$

$$\begin{aligned} {}^{\circ}\text{R} &= 9/5 {}^{\circ}\text{K} \\ &= 9/5 \times 333.16 \\ &= 599.69 \end{aligned}$$

70 °C

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 70 \\ &= 343.16 \end{aligned}$$

$$\begin{aligned} {}^{\circ}\text{R} &= 9/5 {}^{\circ}\text{K} \\ &= 9/5 \times 343.16 \\ &= 617.69 \end{aligned}$$

Three outside temperatures were used in this calculation, these are the average absolute dry bulb temperatures for the column of air between the collar of the intake and the collar of the exhaust shaft (surface):

The average January temperature 5.6 °C (CRWMS M&O 1997, p. A-4)

The average Annual temperature 15.7 °C (CRWMS M&O 1997, p. A-4)

The average July temperature 27.1 °C (CRWMS M&O 1997, p. A-4)

These temperatures were used based on Assumption 3.3.

To convert these temperatures the conversion factors in Section 5.5 are used:

5.6 °C

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 5.6 \\ &= 278.76 \end{aligned}$$

$$\begin{aligned} {}^{\circ}\text{R} &= 9/5 {}^{\circ}\text{K} \\ &= 9/5 \times 278.76 \\ &= 501.77 \end{aligned}$$

15.7 °C

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 15.7 \\ &= 288.86 \end{aligned}$$

$$\begin{aligned} {}^{\circ}\text{R} &= 9/5 {}^{\circ}\text{K} \\ &= 9/5 \times 288.86 \\ &= 519.95 \end{aligned}$$

27.1 °C

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 27.1 \\ &= 300.26 \end{aligned}$$

$$\begin{aligned} {}^{\circ}\text{R} &= 9/5 {}^{\circ}\text{K} \\ &= 9/5 \times 300.26 \\ &= 540.47 \end{aligned}$$

5.2.4.2 Upcast Side

The average temperature for the column of air in the exhaust shaft is calculated from an intake temperature and an exhaust temperature. The intake temperature is the exhaust temperature from the exhaust shaft connectors based on the heat transfer between the air and the rock within the connector. The exhaust temperature is based on the heat transfer between the air and the rock within the shaft and the change in temperature due to effect of autocompression of the air column as it expands due to the change in pressure.

To establish the intake temperature at the exhaust shaft station two heat transfer calculations are required, one for the heat transfer in the exhaust main, and one for the heat transfer in the shaft connectors.

The equations for calculating the exhaust temperatures based on the heat transfer between the air and the rock are found in Section 5.3. The equation for calculating the autocompression of the air column is found in Section 5.2.5.

5.2.5 Autocompression

Autocompression occurs when air enters a shaft and is compressed as it flows downward (Hartman et al. 1997, p. 587).

The factor to apply autocompression to the column of air is:

$$\frac{\text{Change in Dry Bulb Temperature}}{\text{Change in Elevation}} = 9.66 {}^{\circ}\text{C}/1000 \text{ m} \quad (\text{Equation 8})$$

(Hartman et al. 1997, Equation 16.2, p. 588)

The effect of autocompression for the Intake Shaft for Panel 1 is:

$$\begin{aligned}\text{Change in Dry Bulb Temperature} &= [1430-1044 \text{ (Section 5.2)}] \times 9.66^\circ\text{C}/1000 \text{ m} \\ &= 3.73^\circ\text{C}\end{aligned}$$

The effect of autocompression for the Exhaust Shaft for Panel 1 is:

$$\begin{aligned}\text{Change in Dry Bulb Temperature} &= [1460-1013 \text{ (Section 5.2)}] \times 9.66^\circ\text{C}/1000 \text{ m} \\ &= 4.32^\circ\text{C}\end{aligned}$$

5.3 HEAT TRANSFER

The heat transfer calculation are found in the following Attachments:

Heat Transfer Calculation for Intake Shafts	Attachment III
Heat Transfer Calculation for Exhaust Mains	Attachment IV
Heat Transfer Calculation for Exhaust Shaft Connectors	Attachment V
Heat Transfer Calculation for Exhaust Shafts	Attachment VI

The exhaust temperature calculation is derived from two equations in *Heat Transfer* (Holman, J.P. 1997, Equation 6-1, p. 286, and Equation 6-3, p. 286).

$$q = mc_p(T_{airout} - T_{airin}) \quad (\text{Equation 9})$$

$$q = h_c A_s (T_{rock} - T_{air})_{\text{average}} \quad (\text{Equation 10})$$

Where q = heat transfer.

m = mass rate of flow = Air flow rate (Q) x air density (D_e).
or Q in m^3/sec x D_e in kg/m^3 .

c_p = specific heat in kJ/kg .

T = absolute temperature in $^\circ\text{K}$.

h_c = heat transfer coefficient in W/m^2 .

A_s = surface area in m^2 or Perimeter (P) x Length (l)

Therefore by equating Equations 9 and 10:

$$h_c A_s (T_{rock} - T_{air})_{\text{average}} = mc_p (T_{airout} - T_{airin}) \quad (\text{Equation 11})$$

by dividing both side by $h_c A_s$ and substituting $Q D_e$ for m , the equation becomes:

$$(T_{rock} - T_{air})_{\text{average}} = Q D_e c_p / h_c A_s (T_{airout} - T_{airin}) \quad (\text{Equation 11a})$$

by substituting $(T_{airout} + T_{airin})/2$ for T_{airave} , the equation becomes:

$$T_{rockave} - (T_{airout} + T_{airin})/2 = Q D_e c_p / h_c A_s (T_{airout} - T_{airin}) \quad (\text{Equation 11b})$$

by removing the brackets, the equation becomes:

$$T_{rockave} - T_{airout}/2 - T_{airin}/2 = QD_e c_p / h_c A_s \times T_{airout} - QD_e c_p / h_c A_s \times T_{airin} \quad (\text{Equation 11bb})$$

by multiplying both side by $h_c A_s / QD_e c_p$, the equation becomes:

$$(h_c A_s / QD_e c_p) T_{rockave} - (h_c A_s / 2QD_e c_p) T_{airout} - (h_c A_s / 2QD_e c_p) T_{airin} = T_{airout} - T_{airin} \quad (\text{Equation 11c})$$

by separating all the T_{airout} to one side , the equation becomes:

$$(h_c A_s / QD_e c_p) T_{rockave} - (h_c A_s / 2QD_e c_p) T_{airin} + T_{airin} = T_{airout} + (h_c A_s / 2QD_e c_p) T_{airout} \quad (\text{Equation 11d})$$

by dividing both sides by $(1 + h_c A_s / 2QD_e c_p)$, the equation becomes:

$$T_{airout} = [(h_c A_s / QD_e c_p) T_{rockave} - (h_c A_s / 2QD_e c_p) T_{airin} + T_{airin}] / (1 + h_c A_s / 2QD_e c_p) \quad (\text{Equation 11e})$$

The average rock temperature ($T_{rockave}$) is based on averaging the rock temperatures at various points (the start and end of the areas where the heat transfer is occurring). The rock temperatures at these points are calculated in Section 5.3.1.

The equation for calculating the convection heat coefficient (h_c) is found in Section 5.3.2.

The descriptions of how the specific heat (c_p) and air density (D_e) are determined are found in Section 5.3.5.

The description of the profiles used for determining the surface area (A_s) is found in Section 5.4.

The description of how the airflow rate (Q) is estimated is found in Section 5.3.6.

5.3.1 Rock Temperatures

The rock temperature is based on Assumption 3.8, that the average rock temperature at the intake shaft collar is 18.7 °C and the thermal gradient in the rock is 0.020 °C/m for depth 0 to 150 meters, 0.018 °C/m for depth 150 to 400 meters and 0.030 °C/m for depth 400 to 536 meters. The rock temperature is calculated as follows:

Rock Temperature at Intake Shaft Collar = 18.7 °C

Converted to °K (conversion factor from Section 5.5)

$$\begin{aligned} {}^{\circ}\text{K} &= 273.16 + {}^{\circ}\text{C} \\ &= 273.16 + 18.7 \\ &= 291.86 \end{aligned}$$

Rock Temperature at Intake Shaft Station = $18.7 + .02 \times 150 + (386.4 - 150) \times .018 = 25.96^{\circ}\text{C}$

Converted to $^{\circ}\text{K}$ (conversion factor from Section 5.5)

$$\begin{aligned} ^{\circ}\text{K} &= 273.16 + ^{\circ}\text{C} \\ &= 273.16 + 25.96 \\ &= 299.12 \end{aligned}$$

Vertical Distance from Intake Shaft Station to Exhaust Shaft Station = $1044 - 1013 = 31\text{ m}$
(Section 5.2)

Vertical Distance from Intake Shaft Collar to Exhaust Shaft Station = $31 + 386.4 = 417.4\text{ m}$

Rock Temperature at Exhaust Shaft Station = $18.7 + .02 \times 150 + 250 \times .018 + (417.4 - 400) \times .03 = 26.72^{\circ}\text{C}$

Converted to $^{\circ}\text{K}$ (conversion factor from Section 5.5)

$$\begin{aligned} ^{\circ}\text{K} &= 273.16 + ^{\circ}\text{C} \\ &= 273.16 + 26.72 \\ &= 299.88 \end{aligned}$$

5.3.2 Convection Heat Coefficient

The convection heat transfer coefficient (h_c) is calculated from the equation in *Heat Transfer* (Holman, J.P. 1997, p. 296)

$$h_c = kN_u/D_h \quad (\text{Equation 12})$$

Where k = Air thermal conductivity in $\text{W}/\text{m}^{\circ}\text{K}$

N_u = Nusselt number which is dimensionless

D_h = Hydraulic diameter in meters or $4 \times \text{Area (A)} / \text{Perimeter (P)}$
(Holman, J.P. 1997, Equation 6-14, p. 292)

The equation for calculating the Nusselt number (N_u) is found in Section 5.3.3.

The calculations of the Hydraulic Diameter (D_h), Area (A) and Perimeter (P) are found in Attachment III, IV, V and VI.

5.3.3 Nusselt Number

Nusselt number (N_u) is calculated from the equation in *Heat Transfer* (Holman, J.P. 1997, Equation 6-4a, p. 286):

$$N_u = 0.023 R_e^{0.8} P_r^x \quad (\text{Equation 13})$$

Where $x = 0.3$ for cooling and 0.4 for heating.
 R_e = Reynolds number which is dimensionless.
 P_r = Air Prandtl number which is dimensionless.

The equation for calculating the Reynolds number (R_e) is found in Section 5.3.4.

The descriptions of how the air Prandtl number (P_r) is determined is found in Section 5.3.5.

5.3.4 Reynolds Number

Reynolds number (R_e) is calculated from the equation in *Heat Transfer* (Holman, J.P. 1997, p. 521):

$$R_e = D_e v D_h / V_d \quad (\text{Equation 14})$$

Where V_d = Air dynamic viscosity in kg/ms
 v = Air flow velocity in m/s or Air Flow rate (Q) / Area (A)

The descriptions of how the air dynamic viscosity (V_d) is determined is found in Section 5.3.5.

The description of how the airflow rate (Q) is estimated is found in Section 5.3.6.

The description of the profiles used for determining the area (A_s) is found in Section 5.4.

5.3.5 Air Properties

The air dynamic viscosity (V_d), air Prandtl Number (P_r), air specific heat (c_p), air thermal conductivity (k), and air density (D_e) are all air properties which are dependent on temperature and are derived through linear interpolation from the chart in *Heat Transfer* (Holman, J.P. 1997, p. 646).

The calculations of air properties for Panel 1 are found in Attachment VII.

5.3.6 Airflow Rates

The airflow rate is estimated in the heat transfer calculation (see Section 5.3) in order to bound the air flow rates generated from the pressure calculation (see Section 5.2). The estimated airflows are used in Attachments III, IV, V, and VI to calculate dry bulb temperature. The dry bulb temperature, in turn, is used in the pressure calculation to determine natural ventilation pressure, which generates a calculated airflow. If the calculated airflow is approximately the same as the estimated airflows, the calculation is considered to be reasonable for this application.

Airflow rates are estimated in m^3/s per emplacement drift split (two per drift).

The Intake and Exhaust shafts support 17 emplacement drifts (See Assumption 3.1) therefore, the estimated airflow rates for the shafts will be in multiples of 34 ($17 \times 2 = 34$).

The Exhaust Shaft Connectors support 17 emplacement drifts with 2 connectors, therefore the estimated airflow rates for the connectors will be in multiples of 17 ($34 / 2 = 17$).

The Exhaust main supports 17 emplacement drifts with 4 legs, therefore the estimated airflow rates for the Exhaust main will be in multiples of 9 (rounded) ($34 / 4 = 8.5$).

5.4 GEOMETRY

Area is calculated by $\pi \times \text{radius}^2$ for a circle and width \times (height - radius) + $1/2 \pi \times \text{radius}^2$ for a horseshoe shape.

Perimeter is calculated by $\pi \times \text{diameter}$ for a circle and $1/2 \times \pi \times \text{diameter} + \text{width} + 2 \times (\text{height} - \text{radius})$ for a horseshoe shape.

The lengths (L_d) and dimensions of the drifts are inputs.

Drift Lining = 0.3 m (CRWMS M&O 1999b, p. 30).

Intake Shaft length = 386.4 m, extracted from the *Subsurface Facility Planning Layout in Support of ANL-SFS-MG-000001, REV 00* (CRWMS M&O 2000c) using VULCAN V3.4.
Intake Shaft profile = 8.0 m circle (CRWMS M&O 2000a, Section 6.3.2.3).

Exhaust Main average length = 173.5 m

Based on Assumption 3.7, and extracted from the *Subsurface Facility Planning Layout in Support of ANL-SFS-MG-000001, REV 00* (CRWMS M&O 2000c) using VULCAN V3.4.

Exhaust Main profile = 7.62 m circle (CRWMS M&O 2000a, Section 6.3.2.1).

Exhaust Shaft connector average length = 408.3m

Based on Assumption 3.7, and extracted from the *Subsurface Facility Planning Layout in Support of ANL-SFS-MG-000001, REV 00* (CRWMS M&O 2000c) using VULCAN V3.4.

Exhaust Shaft connector profile = 8.0 m wide by 8.5 m high horseshoe (CRWMS M&O 2000a, Section 6.3.2.5).

The exhaust shaft connector perimeter (P) and area (A) are:

$$P = 1/2 \pi \times \text{diameter} + \text{width} + 2 \times (\text{height} - \text{radius})$$

$$\text{Diameter} = \text{width} = \text{excavated width} - 2 \times \text{linings} = 8 - 2 \times 0.3 = 7.4 \text{ m}$$

$$\text{Height} = \text{excavated height} - 2 \times \text{linings} = 8.5 - 2 \times 0.3 = 7.9 \text{ m}$$

$$\text{Radius} = 1/2 \text{ diameter} = 3.7 \text{ m}$$

$$\begin{aligned} P &= 1/2(3.1416) \times (7.4) + (7.4) + 2 \times (7.9 - 3.7) \\ &= 27.42 \text{ m} \end{aligned}$$

$$\begin{aligned} A &= \text{width} \times (\text{height} - \text{radius}) + 1/2 \pi \times \text{radius}^2 \\ &= 7.4 \times (7.9 - 3.7) + 1/2(3.1416) \times 3.7^2 \\ &= 52.58 \text{ m}^2 \end{aligned}$$

Exhaust Shaft length = 448.4m, extracted from the *Subsurface Facility Planning Layout in Support of ANL-SFS-MG-000001, REV 00* (CRWMS M&O 2000c) using VULCAN V3.4. Exhaust Shaft profile = 8.0 m circle (CRWMS M&O 2000a, Section 6.3.2.5).

5.5 CONVERSION FACTORS

The following conversion factors are used throughout.

meter = 3.2808 feet (Holman, J.P. 1997, inside cover).
m³/s = 2118.9 ft³/min. (Hartman et al. 1997, p. 680).
°K = °C + 273.16 (Holman, J.P. 1997, p. 16).
°F = 9/5°C + 32 (Holman, J.P. 1997, p. 16).
°R = °F + 459.69 (Holman, J.P. 1997, p. 16).
°R = 9/5 °K (Holman, J.P. 1997, p. 16).

6. RESULTS

These results are based upon unqualified information and inputs. Therefore, these results are considered TBV.

This document may be affected by technical product input information that requires confirmation. Any changes to the document that may occur as a result of completing the confirmation activities will be reflected in subsequent revisions. The status of the input information quality may be confirmed by review of the Document Input Reference System database.

These results are explicit to the average specific weights of the upcast and downcast air columns and therefore, interpolation/extrapolation of these results would produce erroneous information.

Table 1. Summary of Results

Source Page Number	Input Temperatures Surface Air Temperature (°C) Emplacement Drift Exhaust Temperature (°C) Average Temperature Intake Shaft (°R) Average Temperature Exhaust Shaft (°R)	Head due to Natural Ventilation (h), in. of water	Airflow Rate (Q), m³/s per drift
II-2	5.6 43 509.14 547.98	1.21	6.31
II-3	5.6 43 509.03 548.34	1.23	6.36
II-4	5.6 47 509.14 551.18	1.3	6.54
II-5	5.6 47 509.03 551.63	1.32	6.59
II-6	5.6 50 509.14 553.57	1.36	6.69
II-7	5.6 50 509.03 554.08	1.38	6.74
II-9	5.6 60 509.03 562.14	1.6	7.26
II-8	5.6 60 508.94 562.71	1.62	7.3
II-10	5.6 70 509.03 570.03	1.8	7.7
II-11	5.6 70 508.94 570.79	1.82	7.74
II-12	15.7 43 525.09 547.07	0.64	4.59
II-13	15.7 43 524.97 547.56	0.66	4.66
II-14	15.7 47 525.11 549.50	0.7	4.8

Table 1. Summary of Results (Continued)

Source Page Number	Input Temperatures Surface Air Temperature (°C) Emplacement Drift Exhaust Temperature (°C) Average Temperature Intake Shaft (°R) Average Temperature Exhaust Shaft (°R)	Head due to Natural Ventilation (h), in. of water	Airflow Rate (Q), m³/s per drift
II-15	15.7 47 524.97 550.68	0.75	4.97
II-16	15.7 50 524.97 552.98	0.81	5.17
II-17	15.7 50 524.92 553.57	0.83	5.23
II-18	15.7 60 524.97 560.61	1.01	5.77
II-19	15.7 60 524.92 561.42	1.03	5.82
II-20	15.7 70 524.92 569.13	1.23	6.36
II-21	15.7 70 524.87 570.03	1.26	6.44
II-22	27.1 43 542.19 543.87	N/A	N/A
II-23	27.1 47 542.19 546.09	0.05	1.28
II-24	27.1 47 542.37 547.99	0.11	1.9
II-25	27.1 50 542.37 549.91	0.16	2.3
II-26	27.1 50 542.47 551.31	0.2	2.57

Table 1. Summary of Results (Continued)

Source Page Number	<u>Input Temperatures</u> Surface Air Temperature (°C) Emplacement Drift Exhaust Temperature (°C) Average Temperature Intake Shaft (°R) Average Temperature Exhaust Shaft (°R)	Head due to Natural Ventilation (h), in. of water	Airflow Rate (Q), m ³ /s per drift
II-27	27.1 60 542.47 558.30	0.38	3.54
II-28	27.1 60 542.53 559.63	0.42	3.72
II-29	27.1 70 542.53 566.84	0.6	4.45
II-30	27.1 70 542.58 568.09	0.64	4.59

7. REFERENCES

This section identifies sources of input and other information used in the calculation.

7.1 DOCUMENTS CITED

CRWMS M&O 1997. *Engineering Design Climatology and Regional Meteorological Conditions Report*. B00000000-01717-5707-00066 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980304.0028.

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CRWMS M&O 2000b. *Technical Work Plan for: Natural Ventilation Parametric Study*. TWP-SVS-SE-000001 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000922.0012.

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Sass, J.H.; Lachenbruch, A.H.; Dudley, W.W., Jr.; Priest, S.S.; and Munroe, R.J. 1988. *Temperature, Thermal Conductivity, and Heat Flow Near Yucca Mountain, Nevada: Some Tectonic and Hydrologic Implications*. Open-File Report 87-649. [Denver, Colorado]: U.S. Geological Survey. TIC: 203195.

7.2 SOFTWARE CODES

CRWMS M&O 1999aa. *Software Code: VULCAN V3.4*. V3.4. UNIX. 10044-3.4-00. URN-0528

7.3 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

AP-3.12Q, Rev. 0, ICN 3. *Calculations*. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20001026.0084.

AP-SI.1Q, Rev. 2, ICN 4., ECN 1 *Software Management*. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20001019.0023.

8. ATTACHMENTS

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ATTACHMENT I
AIRWAY RESISTANCE CALCULATION

This attachment calculates the average airway resistance for Assumption 3.2.

ATTACHMENT I

AIRWAY RESISTANCE CALCULATION

Airway Resistance Calculation based on Assumption 3.2, that the resistance of Panel 1 is equivalent to the average resistance across the two center exhaust shafts from system B in *Design Feature 7: Continuous Preclosure Ventilation* (CRWMS M&O 1999a, p. 30).

1 st MidEmplShaft Fan	$Q = 1303.19 \text{ kcfm}$, $p = 9.818 \text{ in. wg}$ from (CRWMS M&O 1999a, Appendix E, p. 19)
2 nd MidEmplShaft Fan	$Q = 1300.26 \text{ kcfm}$, $p = 9.985 \text{ in. wg}$ from (CRWMS M&O 1999a, Appendix E, p. 19)
1 st MidEmplShaft Fan	$r_1 = h/Q^2$ (Equation 1a) $r_1 = 9.818/1303190^2$ $r_1 = 5.78 \times 10^{-12} \text{ in min}^2 / \text{ft}^6$
2 nd MidEmplShaft Fan	$r_2 = h/Q^2$ (Equation 1a) $r_2 = 9.985/1300260^2$ $r_2 = 5.91 \times 10^{-12} \text{ in min}^2 / \text{ft}^6$
Average Resistance	$r_{ave} = (r_1 + r_2) / 2$ $r_{ave} = (5.78 \times 10^{-12} + 5.91 \times 10^{-12}) / 2$ $r_{ave} = 5.85 \times 10^{-12} \text{ in min}^2 / \text{ft}^6$

ATTACHMENT II
PRESSURE CALCULATIONS

This attachment calculates the various specific weights of different columns of air at different average temperatures. The specific weights are used to determine the natural ventilation head and airflows.

ATTACHMENT II

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	43	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	6	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	509.14	From Attachment III, p. III-2
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670217	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	569.09	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0614981	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	547.98	From Attachment VI, p. VI- 3
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0622955	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.21	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	454794.03	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	214.64	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	6.31	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	43	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	7	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	509.03	From Attachment III, p. III-3
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670362	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	569.09	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0614981	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	548.34	From Attachment VI, p. VI- 4
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0622546	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.23	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	458537.25	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	216.4	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	6.36	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	47	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	6	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	509.14	From Attachment III, p. III-2
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670217	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	576.29	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0607297	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	551.18	From Attachment VI, p. VI- 6
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0619338	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.3	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	471404.52	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	222.48	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	6.54	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	47	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	7	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	509.03	From Attachment III, p. III-3
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670362	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	576.29	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0607297	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	551.63	From Attachment VI, p. VI- 7
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0618833	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.32	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	475016.87	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	224.18	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	6.59	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	50	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	6	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	509.14	From Attachment III, p. III-2
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670217	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	581.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.060166	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	553.57	From Attachment VI, p. VI-9
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0616664	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.36	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	482160.38	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	227.55	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	6.69	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	50	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	7	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	509.03	From Attachment III, p. III-3
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670362	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	581.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.060166	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	554.08	From Attachment VI, p. VI-9
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0616097	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.38	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	485692.74	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	229.22	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	6.74	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	60	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	8	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	508.94	From Attachment III, p. III-2
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670481	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	599.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0583601	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	562.71	From Attachment VI, p. VI-12
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0606648	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.62	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	526234.81	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	248.35	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	7.3	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	60	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	7	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	509.03	From Attachment III, p. III-3
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670362	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	599.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0583601	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	562.14	From Attachment VI, p. VI-12
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0607263	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.6	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	522976.36	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	246.82	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	7.26	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	70	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	7	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	509.03	From Attachment III, p. III-3
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670362	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	617.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0566594	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	570.03	From Attachment VI, p. VI-13
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0598858	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.8	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	554700.2	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	261.79	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	7.7	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	5.6	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	70	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	8	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	501.77	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0662897	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	508.94	From Attachment III, p. III-2
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0670481	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	617.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0566594	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	570.79	From Attachment VI, p. VI-15
Vapor Pressure (p _v), in. Hg.	0.07	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.059806	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.82	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	557773.35	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	263.24	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	7.74	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	43	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	4	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	525.09	From Attachment III, p. III-6
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0649191	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	569.09	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0614365	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	547.07	From Attachment VI, p. VI-2
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.062335	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.64	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	330759.29	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	156.1	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	4.59	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	43	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	5	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	524.97	From Attachment III, p. III-7
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.064934	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	569.09	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0614365	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	547.56	From Attachment VI, p. VI-3
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0622793	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.66	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	335887.65	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	158.52	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	4.66	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	47	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	4	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	525.09	From Attachment III, p. III-6
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0649191	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	576.29	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0606689	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	549.5	From Attachment VI, p. VI-4
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0620594	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.7	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	345916.35	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	163.25	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	4.8	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	47	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	5	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	524.97	From Attachment III, p. III-7
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.064934	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	576.29	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0606689	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	550.68	From Attachment VI, p. VI-6
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0619264	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.75	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	358057.44	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	168.98	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	4.97	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	50	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	5	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	524.97	From Attachment III, p. III-7
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.064934	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	581.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0601057	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	552.98	From Attachment VI, p. VI-7
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0616688	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.81	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	372104.2	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	175.61	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	5.17	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	50	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	6	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	524.92	From Attachment III, p. III-6
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0649401	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	581.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0601057	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	553.57	From Attachment VI, p. VI-9
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0616031	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.83	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	376670.07	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	177.77	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	5.23	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	60	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	5	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	524.97	From Attachment III, p. III-7
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.064934	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	599.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0583016	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	560.61	From Attachment VI, p. VI-10
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0608295	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.01	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	415511.22	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	196.1	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	5.77	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	60	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	6	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	524.92	From Attachment III, p. III-6
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0649401	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	599.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0583016	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	561.42	From Attachment VI, p. VI-10
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0607417	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.03	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	419605.02	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	198.03	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	5.82	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	70	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	6	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	524.92	From Attachment III, p. III-6
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0649401	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	617.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0566026	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	569.13	From Attachment VI, p. VI-14
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0599189	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.23	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	458537.25	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	216.4	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	6.36	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	15.7	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	70	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	7	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	519.95	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0639045	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	524.87	From Attachment III, p. III-7
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0649463	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	617.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0566026	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	570.03	From Attachment VI, p. VI-13
Vapor Pressure (p _v), in. Hg.	0.14	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0598243	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	1.26	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	464095.48	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	219.03	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	6.44	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	43	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	1	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.19	From Attachment III, p. III-4
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0627331	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	569.09	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0613045	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	543.87	From Attachment VI, p. VI-2
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0625637	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	-0.01	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	N/A	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	N/A	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	N/A	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	47	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	1	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.19	From Attachment III, p. III-4
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0627331	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	576.29	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0605385	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	546.09	From Attachment VI, p. VI-5
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0623093	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.05	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	92450.03	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	43.63	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	1.28	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	47	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	2	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.37	From Attachment III, p. III-3
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0627123	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	576.29	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0605385	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	547.99	From Attachment VI, p. VI-5
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0620933	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.11	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	137125.56	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	64.72	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	1.9	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	50	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	2	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.37	From Attachment III, p. III-3
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0627123	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	581.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0599765	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	549.91	From Attachment VI, p. VI-8
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0618765	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.16	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	165379.65	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	78.05	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	2.3	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	50	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	3	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.47	From Attachment III, p. III-5
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0627007	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	581.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0599765	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	551.31	From Attachment VI, p. VI-8
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0617194	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.2	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	184900.07	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	87.26	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	2.57	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	60	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	3	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.47	From Attachment III, p. III-5
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0627007	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	599.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0581763	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	558.3	From Attachment VI, p. VI-11
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0609466	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.38	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	254867.15	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	120.28	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	3.54	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	60	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	4	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.53	From Attachment III, p. III-4
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0626938	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	599.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.0581763	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	559.63	From Attachment VI, p. VI-11
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0608018	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.42	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	267945.65	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	126.46	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	3.72	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	70	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	4	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.53	From Attachment III, p. III-4
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.0626938	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	617.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.056481	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	566.84	From Attachment VI, p. VI-13
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0600284	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.6	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	320256.31	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	151.14	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	4.45	Airflow Rate / Drift Splits from Section 5.3.6

Description	Value	Source / Equation
Surface Air Temperature, °C	27.1	From Section 5.2.4.1
Emplacement Drift Exhaust Temperature, °C	70	From Section 3.5
Estimated Airflow per Emplacement Split, m ³ /s	5	Estimated, see Section 5.3.6
Downcast Side		
Height of Column Surface (L _o), ft	98.43	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	540.47	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.13	From Attachment VII, p. VII-14
Specific Weight (W _o), lb/ft ³	0.0613392	Equation 6, Section 5.2.1
Height of Column Intake Shaft (L _i), ft	1266.38	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	542.58	From Attachment III, p. III-5
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.78	From Attachment VII, p. VII-14
Specific Weight (W _i), lb/ft ³	0.062688	Equation 6, Section 5.2.1
Height of Column Repository Level (L _r), ft	101.71	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	617.69	From Section 5.2.4.1
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	26.44	From Attachment VII, p. VII-14
Specific Weight (W _r), lb/ft ³	0.056481	Equation 6, Section 5.2.1
Upcast Side		
Height of Column Exhaust Shaft (L _e), ft	1466.52	From Section 5.2
Average Dry Bulb Temperature (T _d), °R	568.09	From Attachment VI, p. VI-14
Vapor Pressure (p _v), in. Hg.	0.29	From Section 5.2.3
Barometric Pressure (p _b), in. Hg.	25.79	From Attachment VII, p. VII-14
Specific Weight (W _e), lb/ft ³	0.0598963	Equation 6, Section 5.2.1
Head due to Natural Ventilation (h), in. of water	0.64	Equation 2c, Section 5.2
Resistance (r), in min ² / ft ⁶	5.85E-12	From Attachment I, p. I-2
Airflow rate (Q) ft ³ / min	330759.29	Equation 1, Section 5.1
Airflow rate (Q) m ³ /s	156.1	Converted with conversion factor from Section 5.5
Airflow rate (Q) m ³ /s per drift split	4.59	Airflow Rate / Drift Splits from Section 5.3.6

ATTACHMENT III

HEAT TRANSFER CALCULATION FOR INTAKE SHAFTS

This attachment calculates the change in temperature, based on the heat transfer for various airflow quantities and due to autocompression, in the intake shafts.

ATTACHMENT III

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P = \pi * \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	43.01	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	278.76	From Section 5.2.4.1
Air Density (D_e), kg/m^3	1.2774	From Attachment VII, p. 14
Air Thermal Conductivity (k), $\text{W/m}^\circ\text{K}$	0.02455	From Attachment VII, p. 14
Air Specific Heat (c_p), $\text{J/kg}^\circ\text{K}$	1005.5	From Attachment VII, p. 14
Air Dynamic Viscosity (V_d), kg/ms	1.7412E-05	From Attachment VII, p. 14
Air Prandtl Number (P_t), dimensionless	0.714	From Attachment VII, p. 14
Air Flow Rate (Q), m^3/s	272	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	6.32	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	3431050.03	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	3400.55	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), $\text{W/m}^{20}\text{K}$	11.28	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	283	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	286.73	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	516.11	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	501.77	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	508.94	$(T_{exhaust} + T_{airin})/2$

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P = \pi \cdot \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	278.76	From Section 5.2.4.1
Air Density (D_e), kg/m ³	1.2774	From Attachment VII, p. 14
Air Thermal Conductivity (k), W/m°K	0.02455	From Attachment VII, p. 14
Air Specific Heat (c_p), J/kg°K	1005.5	From Attachment VII, p. 14
Air Dynamic Viscosity (ν_d), kg/ms	1.7412E-05	From Attachment VII, p. 14
Air Prandtl Number (P_f), dimensionless	0.714	From Attachment VII, p. 14
Air Flow Rate (Q), m ³ /s	204	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	4.74	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2573287.53	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2701.46	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	8.96	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	283.22	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	286.95	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	516.51	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	501.77	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	509.14	$(T_{exhaust} + T_{airin})/2$

Surface Air Temperature, °C 5.6 From Section 5.2.4.1
 Estimated Airflow per Emplacement Split, m³/s 7 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	278.76	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.2774	From Attachment VII, p. 14
Air Thermal Conductivity (k), W/m°K	0.02455	From Attachment VII, p. 14
Air Specific Heat (c_p), J/kg°K	1005.5	From Attachment VII, p. 14
Air Dynamic Viscosity (ν_d), kg/ms	1.7412E-05	From Attachment VII, p. 14
Air Prandtl Number (P_r), dimensionless	0.714	From Attachment VII, p. 14
Air Flow Rate (Q), m ³ /s	238	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	5.53	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	3002168.78	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	3056.01	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	10.14	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	283.1	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	286.83	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	516.29	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	501.77	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	509.03	$(T_{exhaust} + T_{airin})/2$

Surface Air Temperature, °C 27.1 From Section 5.2.4.1
 Estimated Airflow per Emplacement Split, m³/s 2 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	300.26	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.1765	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02626	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.7	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.8474E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.708	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	68	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.58	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	744594.46	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1033.41	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	3.67	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	298.64	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	302.37	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	544.27	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	540.47	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	542.37	$(T_{exhaust} + T_{airin})/2$

Surface Air Temperature, °C 27.1 From Section 5.2.4.1
 Estimated Airflow per Emplacement Split, m³/s 4 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	300.26	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.1765	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02626	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.7	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.8474E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.708	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	136	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.16	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	1489188.91	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1799.28	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	6.39	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	($T_{rt} + T_{rb}$)/2
Outlet Air Temp. (T_{airout}), °K	298.82	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	302.55	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	544.59	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	540.47	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	542.53	($T_{exhaust} + T_{airin}$)/2

Surface Air Temperature, °C 27.1 From Section 5.2.4.1
 Estimated Airflow per Emplacement Split, m³/s 1 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	300.26	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.1765	From Attachment VII, p. 13
Conv. Heat Transfer Coef. (h_c), W/m ² K	0.02626	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.7	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.8474E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.708	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	34	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.79	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	372297.23	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	593.54	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	2.11	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	($T_{rt} + T_{rb}$)/2
Outlet Air Temp. (T_{airout}), °K	298.44	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	302.17	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	543.91	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	540.47	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	542.19	($T_{exhaust} + T_{airin}$)/2

Surface Air Temperature, °C 27.1 From Section 5.2.4.1
 Estimated Airflow per Emplacement Split, m³/s 5 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	300.26	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.1765	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02626	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.7	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	0.000018474	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.708	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	170	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.95	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	1861486.14	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2150.93	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	7.63	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	($T_{rt} + T_{rb}$)/2
Outlet Air Temp. (T_{airout}), °K	298.87	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	302.6	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	544.68	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	540.47	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	542.58	($T_{exhaust} + T_{airin}$)/2

Surface Air Temperature, °C 27.1 From Section 5.2.4.1
 Estimated Airflow per Emplacement Split, m³/s 3 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	300.26	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.1765	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02626	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.7	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.8474E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.708	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	102	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.37	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	1116891.69	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1429.38	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	5.07	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	($T_{rt} + T_{rb}$)/2
Outlet Air Temp. (T_{airout}), °K	298.75	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	302.48	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	544.46	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	540.47	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	542.47	($T_{exhaust} + T_{airin}$)/2

Surface Air Temperature, °C 15.7
 Estimated Airflow per Emplacement Split, m³/s 4
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	288.86	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.2298	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02536	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.6	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.7911E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.711	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	136	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.16	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	1605585.57	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1913.35	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	6.56	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	290.84	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	294.57	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	530.23	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	519.95	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	525.09	$(T_{exhaust} + T_{airin})/2$

Surface Air Temperature, °C 15.7
 Estimated Airflow per Emplacement Split, m³/s 6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	288.86	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.2298	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02536	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.6	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.7911E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.711	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	204	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	4.74	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	2408378.36	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2557.73	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	8.77	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	290.65	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	294.38	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	529.88	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	519.95	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	524.92	$(T_{exhaust} + T_{airin})/2$

Surface Air Temperature, °C 15.7 From Section 5.2.4.1
 Estimated Airflow per Emplacement Split, m³/s 5 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	288.86	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.2298	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02536	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.6	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.7911E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.711	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	170	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.95	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	2006981.97	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2210.60	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	7.58	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	290.71	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	294.44	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	529.99	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	519.95	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	524.97	$(T_{exhaust} + T_{airin})/2$

Surface Air Temperature, °C 15.7 From Section 5.2.4.1
 Estimated Airflow per Emplacement Split, m³/s 7 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Intake Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	386.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	8983.8	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	288.86	From Section 5.2.4.1
Air Density (D_a), kg/m ³	1.2298	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02536	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1005.6	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.7911E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.711	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	238	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	5.53	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	2809774.75	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2893.43	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	9.92	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.12	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.49	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	290.6	Equation 11e, Section 5.3
Autocompression, °K	3.73	Section 5.2.5
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °K	294.33	$T_{airout} + \text{Autocompression}$, Section 5.2.4.1
Intake Shaft Exhaust Temp. ($T_{exhaust}$), °R	529.79	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	519.95	Converted with conversion factor from Section 5.5.
Intake Shaft Average Temp. (T_d), °R	524.87	$(T_{exhaust} + T_{airin})/2$

ATTACHMENT IV

HEAT TRANSFER CALCULATION FOR EXHAUST MAIN

This attachment calculates the change in temperature, based on the heat transfer for various airflow quantities, in the exhaust main.

ATTACHMENT IV

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

43
 1
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	$P = \pi * \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	316.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1194	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02746	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9201E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	9	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.23	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	94129.64	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	197.23	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	0.77	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rl}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rl} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	312.03	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

43
 4
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	$P = \pi * \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	316.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1194	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02746	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9201E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	36	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.93	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	380611.16	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	603.09	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	2.36	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rl}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rl} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	312.9	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

43
 5
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	316.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1194	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02746	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9201E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	45	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.16	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	474740.80	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	719.72	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	2.82	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	313.03	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

43
 6
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	316.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1194	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02746	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9201E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	54	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.40	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	572963.03	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	836.57	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	3.27	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	313.12	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

43
 7
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	316.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1194	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02746	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9201E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	63	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.63	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	667092.67	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	944.82	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.70	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	313.21	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

47
 2
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	320.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1051	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02777	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9385E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	18	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.47	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	188092.18	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	343.16	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	1.36	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	315.5	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

47
 5

From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	$P=\pi \times \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P \times \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 \times (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	320.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1051	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02777	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9385E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	45	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.16	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	464227.51	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	706.94	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	2.82	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	316.24	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

47
 6

From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	$P=\pi \times \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P \times \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 \times (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	320.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1051	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02777	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9385E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	54	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.40	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	560274.58	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	821.71	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.25	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	316.36	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

47
 7
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	$P=\pi \times \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P \times \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4 \times (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	320.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1051	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02777	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9385E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	63	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.63	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	652319.69	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	928.04	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.67	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	316.47	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

47
 1
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	$P=\pi \times \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P \times \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4 \times (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	320.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1051	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02777	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9385E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	9	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.23	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	92045.11	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	193.73	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	0.77	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	314.96	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

47
 4
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	320.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.1051	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02777	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9385E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.704	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	36	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.93	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	372182.40	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	592.39	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	2.34	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	316.08	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

50
 2
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	323.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0943	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.028	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.2	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9522E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.703	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	18	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.47	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	184946.90	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	338.42	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	1.35	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	317.8	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

50
 3
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	323.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0943	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.028	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.2	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9522E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.703	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	27	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.70	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	275452.83	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	465.43	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	1.86	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	318.19	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

50
 6
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	323.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0943	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.028	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.2	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9522E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.703	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	54	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.40	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	550905.67	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	810.36	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.23	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	318.78	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

50
 5
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	323.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0943	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.028	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.2	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9522E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.703	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	45	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.16	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	456464.69	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	697.17	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	2.78	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	318.65	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

50
 7
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	323.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0943	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.028	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.2	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9522E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.703	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	63	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.63	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	641411.60	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	615.22	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.65	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	318.91	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

60 From Assumption 3.5
 6 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	333.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0584	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02875	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.9	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9979E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.701	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	54	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.40	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	520644.44	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	773.88	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.17	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	326.82	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

60 From Assumption 3.5
 7 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	333.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0584	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02875	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.9	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9979E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.701	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	63	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.63	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	606178.88	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	874.03	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.58	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	327.01	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

60
 4
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	333.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0584	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02875	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.9	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9979E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.701	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	36	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.93	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	345856.66	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	557.90	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	2.28	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	326.37	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

60
 5
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	333.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0584	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02875	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.9	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9979E-05	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.701	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	45	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.16	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	431391.10	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	665.79	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	2.73	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	326.63	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

60
 8
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	$P=\pi \times \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P \times \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4 \times (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	333.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0584	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02875	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.9	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9979E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.701	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	72	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.86	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	691713.32	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	971.37	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.98	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	327.16	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

60
 3
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	$P=\pi \times \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P \times \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4 \times (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	333.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0584	From Attachment VII, p. 12
Air Thermal Conductivity (k), W/m°K	0.02875	From Attachment VII, p. 12
Air Specific Heat (c_p), J/kg°K	1007.9	From Attachment VII, p. 12
Air Dynamic Viscosity (ν_d), kg/ms	1.9979E-05	From Attachment VII, p. 12
Air Prandtl Number (P_r), dimensionless	0.701	From Attachment VII, p. 12
Air Flow Rate (Q), m ³ /s	27	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.70	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	260322.22	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	444.48	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	1.82	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	325.98	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

70
 7
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	343.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0225	From Attachment VII, p. 14
Air Thermal Conductivity (k), W/m°K	0.02951	From Attachment VII, p. 14
Air Specific Heat (c_p), J/kg°K	1008.5	From Attachment VII, p. 14
Air Dynamic Viscosity (ν_d), kg/ms	2.0437E-05	From Attachment VII, p. 14
Air Prandtl Number (P_r), dimensionless	0.699	From Attachment VII, p. 14
Air Flow Rate (Q), m ³ /s	63	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.63	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	572493.93	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	834.23	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.51	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	335.05	Equation 11e, Section 5.3
Air Temperature from Emplacement Drifts °C	70	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	8	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Main		
Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	343.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0225	From Attachment VII, p. 14
Air Thermal Conductivity (k), W/m°K	0.02951	From Attachment VII, p. 14
Air Specific Heat (c_p), J/kg°K	1008.5	From Attachment VII, p. 14
Air Dynamic Viscosity (ν_d), kg/ms	2.0437E-05	From Attachment VII, p. 14
Air Prandtl Number (P_r), dimensionless	0.699	From Attachment VII, p. 14
Air Flow Rate (Q), m ³ /s	72	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.86	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	653275.29	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	927.15	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.90	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	335.26	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

70
 5
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	343.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0225	From Attachment VII, p. 14
Air Thermal Conductivity (k), W/m°K	0.02951	From Attachment VII, p. 14
Air Specific Heat (c_p), J/kg°K	1008.5	From Attachment VII, p. 14
Air Dynamic Viscosity (ν_d), kg/ms	2.0437E-05	From Attachment VII, p. 14
Air Prandtl Number (P_r), dimensionless	0.699	From Attachment VII, p. 14
Air Flow Rate (Q), m ³ /s	45	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.16	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	407418.99	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	635.48	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	2.67	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	334.58	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

70
 6
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	343.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0225	From Attachment VII, p. 14
Air Thermal Conductivity (k), W/m°K	0.02951	From Attachment VII, p. 14
Air Specific Heat (c_p), J/kg°K	1008.5	From Attachment VII, p. 14
Air Dynamic Viscosity (ν_d), kg/ms	2.0437E-05	From Attachment VII, p. 14
Air Prandtl Number (P_r), dimensionless	0.699	From Attachment VII, p. 14
Air Flow Rate (Q), m ³ /s	54	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.40	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	491712.58	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	738.65	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.11	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	334.81	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Main

70
 4
 From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	173.5	From Section 5.4
Drift Diameter, m	7.02	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	22.05	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.02	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	3825.68	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	38.70	$A=\pi/4*(\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	343.16	From Assumption 3.5
Air Density (D_a), kg/m ³	1.0225	From Attachment VII, p. 14
Air Thermal Conductivity (k), W/m°K	0.02951	From Attachment VII, p. 14
Air Specific Heat (c_p), J/kg°K	1008.5	From Attachment VII, p. 14
Air Dynamic Viscosity (ν_d), kg/ms	2.0437E-05	From Attachment VII, p. 14
Air Prandtl Number (P_f), dimensionless	0.699	From Attachment VII, p. 14
Air Flow Rate (Q), m ³ /s	36	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.93	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	326637.64	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	532..51	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_o), W/m ² °K	2.24	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	334.2	Equation 11e, Section 5.3

ATTACHMENT V

HEAT TRANSFER CALCULATION FOR EXHAUST SHAFT CONNECTORS

This attachment calculates the change in temperature, based on the heat transfer for various airflow quantities, in the exhaust shaft connectors.

ATTACHMENT V

Air Temperature from Emplacement Drifts °C 43
 Estimated Airflow per Emplacement Split, m³/s 1
 Heat Transfer Calculation for the Exhaust Shaft Connectors From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	312.03	From Attachment IV, p. 2
Air Density (D_e), kg/m ³	1.1342	From Attachment VII, p. 2
Air Thermal Conductivity (k), W/m°K	0.02715	From Attachment VII, p. 2
Air Specific Heat (c_p), J/kg°K	1006.5	From Attachment VII, p. 2
Air Dynamic Viscosity (V_d), kg/ms	0.000019012	From Attachment VII, p. 2
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 2
Air Flow Rate (Q), m ³ /s	17	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.32	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	146422.28	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	280.98	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	0.99	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	306.63	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C 43
 Estimated Airflow per Emplacement Split, m³/s 4
 Heat Transfer Calculation for the Exhaust Shaft Connectors From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	312.9	From Attachment IV, p. 2
Air Density (D_e), kg/m ³	1.1311	From Attachment VII, p. 4
Air Thermal Conductivity (k), W/m°K	0.02722	From Attachment VII, p. 4
Air Specific Heat (c_p), J/kg°K	1006.6	From Attachment VII, p. 4
Air Dynamic Viscosity (V_d), kg/ms	0.000019052	From Attachment VII, p. 4
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 4
Air Flow Rate (Q), m ³ /s	68	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.29	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	587415.64	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	853.77	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	3.03	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	308.22	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	313.03	From Attachment IV, p. 3
Air Density (D_a), kg/m ³	1.1306	From Attachment VII, p. 6
Air Thermal Conductivity (k), W/m°K	0.02723	From Attachment VII, p. 6
Air Specific Heat (c_p), J/kg°K	1006.6	From Attachment VII, p. 6
Air Dynamic Viscosity (ν_d), kg/ms	0.000019058	From Attachment VII, p. 6
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 6
Air Flow Rate (Q), m ³ /s	85	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.62	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	737126.52	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1023.81	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	3.63	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	308.46	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	313.12	From Attachment IV, p. 3
Air Density (D_a), kg/m ³	1.1303	From Attachment VII, p. 8
Air Thermal Conductivity (k), W/m°K	0.02723	From Attachment VII, p. 8
Air Specific Heat (c_p), J/kg°K	1006.6	From Attachment VII, p. 8
Air Dynamic Viscosity (ν_d), kg/ms	0.000019062	From Attachment VII, p. 8
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 8
Air Flow Rate (Q), m ³ /s	102	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.94	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	882312.35	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1182.18	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	4.20	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	308.66	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

43

7

From Assumption 3.5

Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	313.21	From Attachment IV, p. 4
Air Density (D_a), kg/m ³	1.13	From Attachment VII, p. 10
Air Thermal Conductivity (k), W/m°K	0.02724	From Attachment VII, p. 10
Air Specific Heat (c_p), J/kg°K	1006.6	From Attachment VII, p. 10
Air Dynamic Viscosity (ν_d), kg/ms	0.000019066	From Attachment VII, p. 10
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 10
Air Flow Rate (Q), m ³ /s	119	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.26	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	1027360.01	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1335.25	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	4.74	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	308.84	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

47

1

From Assumption 3.5

Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	314.96	From Attachment IV, p. 6
Air Density (D_a), kg/m ³	1.1237	From Attachment VII, p. 2
Air Thermal Conductivity (k), W/m°K	0.02737	From Attachment VII, p. 2
Air Specific Heat (c_p), J/kg°K	1006.7	From Attachment VII, p. 2
Air Dynamic Viscosity (ν_d), kg/ms	0.000019147	From Attachment VII, p. 2
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 2
Air Flow Rate (Q), m ³ /s	17	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.32	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	144043.94	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	277.32	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	0.99	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	308.21	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

47

2

From Assumption 3.5

Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	315.5	From Attachment IV, p. 4
Air Density (D_a), kg/m ³	1.1218	From Attachment VII, p. 4
Air Thermal Conductivity (k), W/m°K	0.02741	From Attachment VII, p. 4
Air Specific Heat (c_p), J/kg°K	1006.7	From Attachment VII, p. 4
Air Dynamic Viscosity (ν_d), kg/ms	0.000019171	From Attachment VII, p. 4
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 4
Air Flow Rate (Q), m ³ /s	34	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.65	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	291728.86	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	487.72	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	1.74	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	309.18	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

47

4

From Assumption 3.5

Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	316.08	From Attachment IV, p. 7
Air Density (D_a), kg/m ³	1.1197	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02746	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	0.000019198	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	68	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.29	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	578969.58	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	843.94	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	3.02	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	309.86	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	316.24	From Attachment IV, p. 5
Air Density (D_a), kg/m ³	1.1191	From Attachment VII, p. 6
Air Thermal Conductivity (k), W/m°K	0.02747	From Attachment VII, p. 6
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 6
Air Dynamic Viscosity (ν_d), kg/ms	0.000019205	From Attachment VII, p. 6
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 6
Air Flow Rate (Q), m ³ /s	85	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.62	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	724044.01	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1008.82	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	3.61	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	310.54	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	316.36	From Attachment IV, p. 5
Air Density (D_a), kg/m ³	1.1187	From Attachment VII, p. 8
Air Thermal Conductivity (k), W/m°K	0.02748	From Attachment VII, p. 8
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 8
Air Dynamic Viscosity (ν_d), kg/ms	0.000019211	From Attachment VII, p. 8
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 8
Air Flow Rate (Q), m ³ /s	102	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.94	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	866484.42	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1164.68	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	4.17	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	310.79	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	316.47	From Attachment IV, p. 6
Air Density (D_a), kg/m ³	1.1183	From Attachment VII, p. 10
Air Thermal Conductivity (k), W/m°K	0.02749	From Attachment VII, p. 10
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 10
Air Dynamic Viscosity (ν_d), kg/ms	0.000019216	From Attachment VII, p. 10
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 10
Air Flow Rate (Q), m ³ /s	119	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.26	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	1008786.21	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1315.34	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	4.71	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	($T_{rt} + T_{rb}$)/2
Outlet Air Temp. (T_{airout}), °K	311.01	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	317.8	From Attachment IV, p. 7
Air Density (D_a), kg/m ³	1.1135	From Attachment VII, p. 2
Air Thermal Conductivity (k), W/m°K	0.02759	From Attachment VII, p. 2
Air Specific Heat (c_p), J/kg°K	1006.9	From Attachment VII, p. 2
Air Dynamic Viscosity (ν_d), kg/ms	0.000019277	From Attachment VII, p. 2
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 2
Air Flow Rate (Q), m ³ /s	34	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.65	v=Q/A, Section 5.3.4
Reynolds Number (R_e), dimensionless	287978.12	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	482.49	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	1.74	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	($T_{rt} + T_{rb}$)/2
Outlet Air Temp. (T_{airout}), °K	310.51	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	318.65	From Attachment IV, p. 9
Air Density (D_a), kg/m ³	1.1105	From Attachment VII, p. 6
Air Thermal Conductivity (k), W/m°K	0.02765	From Attachment VII, p. 6
Air Specific Heat (c_p), J/kg°K	1006.9	From Attachment VII, p. 6
Air Dynamic Viscosity (ν_d), kg/ms	0.000019315	From Attachment VII, p. 6
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 6
Air Flow Rate (Q), m ³ /s	85	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.62	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	714388.13	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	998.04	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	3.60	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	312.08	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	318.78	From Attachment IV, p. 8
Air Density (D_a), kg/m ³	1.11	From Attachment VII, p. 8
Air Thermal Conductivity (k), W/m°K	0.02766	From Attachment VII, p. 8
Air Specific Heat (c_p), J/kg°K	1006.9	From Attachment VII, p. 8
Air Dynamic Viscosity (ν_d), kg/ms	0.000019321	From Attachment VII, p. 8
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 8
Air Flow Rate (Q), m ³ /s	102	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.94	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	854851.09	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1152.16	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	4.15	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	312.38	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C	50	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	3	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Shaft Connectors		

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	318.19	From Attachment IV, p. 8
Air Density (D_e), kg/m^3	1.1121	From Attachment VII, p. 4
Air Thermal Conductivity (k), W/m^0K	0.02762	From Attachment VII, p. 4
Air Specific Heat (c_p), J/kg^0K	1006.9	From Attachment VII, p. 4
Air Dynamic Viscosity (ν_d), kg/ms	0.000019294	From Attachment VII, p. 4
Air Prandtl Number (P_t), dimensionless	0.704	From Attachment VII, p. 4
Air Flow Rate (Q), m^3/s	51	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.97	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	428833.46	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	663.48	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), $W/m^{20}K$	2.39	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	311.24	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C	50	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	7	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Shaft Connectors		

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	318.91	From Attachment IV, p. 9
Air Density (D_e), kg/m^3	1.1096	From Attachment VII, p. 10
Air Thermal Conductivity (k), $W/m^{\circ}K$	0.02767	From Attachment VII, p. 10
Air Specific Heat (c_p), $J/kg^{\circ}K$	1006.9	From Attachment VII, p. 10
Air Dynamic Viscosity (V_d), kg/ms	0.000019327	From Attachment VII, p. 10
Air Prandtl Number (P_t), dimensionless	0.704	From Attachment VII, p. 10
Air Flow Rate (Q), m^3/s	119	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.26	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	995189.54	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1301.14	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m^2K	4.69	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	312.63	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C	60	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	4	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Shaft Connectors		

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	326.37	From Attachment IV, p. 11
Air Density (D_e), kg/m^3	1.0828	From Attachment VII, p. 4
Air Thermal Conductivity (k), W/m^0K	0.02824	From Attachment VII, p. 4
Air Specific Heat (c_p), J/kg^0K	1007.4	From Attachment VII, p. 4
Air Dynamic Viscosity (ν_d), kg/ms	0.000019669	From Attachment VII, p. 4
Air Prandtl Number (P_t), dimensionless	0.702	From Attachment VII, p. 4
Air Flow Rate (Q), m^3/s	68	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.29	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	544692.06	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	802.69	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), $W/m^{20}K$	2.96	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	316.70	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C	60	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	8	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Shaft Connectors		

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	327.16	From Attachment IV, p. 12
Air Density (D_e), kg/m^3	1.0799	From Attachment VII, p. 12
Air Thermal Conductivity (k), $W/m^{\circ}K$	0.0283	From Attachment VII, p. 12
Air Specific Heat (c_p), $J/kg^{\circ}K$	1007.5	From Attachment VII, p. 12
Air Dynamic Viscosity (V_d), kg/ms	0.000019705	From Attachment VII, p. 12
Air Prandtl Number (P_t), dimensionless	0.702	From Attachment VII, p. 12
Air Flow Rate (Q), m^3/s	136	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.59	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1088684.98	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1396.85	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m^2K	5.15	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	318.26	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C	60	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	3	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Shaft Connectors		

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	325.98	From Attachment IV, p. 12
Air Density (D_e), kg/m^3	1.0842	From Attachment VII, p. 2
Air Thermal Conductivity (k), W/m^0K	0.02821	From Attachment VII, p. 2
Air Specific Heat (c_p), J/kg^0K	1007.4	From Attachment VII, p. 2
Air Dynamic Viscosity (ν_d), kg/ms	0.000019651	From Attachment VII, p. 2
Air Prandtl Number (P_t), dimensionless	0.702	From Attachment VII, p. 2
Air Flow Rate (Q), m^3/s	51	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.97	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	410479.85	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	640.12	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), $W/m^{20}K$	2.35	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	316.01	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C	60	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	5	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Shaft Connectors		

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	326.63	From Attachment IV, p. 11
Air Density (D_e), kg/m^3	1.0819	From Attachment VII, p. 6
Air Thermal Conductivity (k), $W/m^{\circ}K$	0.02826	From Attachment VII, p. 6
Air Specific Heat (c_p), $J/kg^{\circ}K$	1007.5	From Attachment VII, p. 6
Air Dynamic Viscosity (V_d), kg/ms	0.000019681	From Attachment VII, p. 6
Air Prandtl Number (P_t), dimensionless	0.702	From Attachment VII, p. 6
Air Flow Rate (Q), m^3/s	85	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.62	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	683046.61	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	962.03	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m^2K	3.54	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	317.20	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C	60	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	6	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Shaft Connectors		

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	326.82	From Attachment IV, p. 10
Air Density (D_e), kg/m^3	1.0812	From Attachment VII, p. 8
Air Thermal Conductivity (k), W/m^0K	0.02827	From Attachment VII, p. 8
Air Specific Heat (c_p), J/kg^0K	1007.5	From Attachment VII, p. 8
Air Dynamic Viscosity (ν_d), kg/ms	0.000019689	From Attachment VII, p. 8
Air Prandtl Number (P_t), dimensionless	0.702	From Attachment VII, p. 8
Air Flow Rate (Q), m^3/s	102	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.94	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	817108.02	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1110.33	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), $W/m^{20}K$	4.09	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	317.61	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C	60	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	7	Estimated, see Section 5.3.6
Heat Transfer Calculation for the Exhaust Shaft Connectors		

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m^2	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m^2	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	327.01	From Attachment IV, p. 10
Air Density (D_e), kg/m^3	1.0805	From Attachment VII, p. 10
Air Thermal Conductivity (k), $W/m^{\circ}K$	0.02829	From Attachment VII, p. 10
Air Specific Heat (c_p), $J/kg^{\circ}K$	1007.5	From Attachment VII, p. 10
Air Dynamic Viscosity (V_d), kg/ms	0.000019698	From Attachment VII, p. 10
Air Prandtl Number (P_t), dimensionless	0.702	From Attachment VII, p. 10
Air Flow Rate (Q), m^3/s	119	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.26	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	950837.81	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1253.47	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m^2K	4.62	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	317.98	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	334.2	From Attachment IV, p. 15
Air Density (D_a), kg/m ³	1.0547	From Attachment VII, p. 2
Air Thermal Conductivity (k), W/m°K	0.02883	From Attachment VII, p. 2
Air Specific Heat (c_p), J/kg°K	1008	From Attachment VII, p. 2
Air Dynamic Viscosity (ν_d), kg/ms	0.000020027	From Attachment VII, p. 2
Air Prandtl Number (P_r), dimensionless	0.7	From Attachment VII, p. 2
Air Flow Rate (Q), m ³ /s	68	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.29	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	521072.46	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	774.06	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	2.91	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	321.58	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	335.26	From Attachment IV, p. 13
Air Density (D_a), kg/m ³	1.0509	From Attachment VII, p. 10
Air Thermal Conductivity (k), W/m°K	0.02891	From Attachment VII, p. 10
Air Specific Heat (c_p), J/kg°K	1008	From Attachment VII, p. 10
Air Dynamic Viscosity (ν_d), kg/ms	0.000020075	From Attachment VII, p. 10
Air Prandtl Number (P_r), dimensionless	0.7	From Attachment VII, p. 10
Air Flow Rate (Q), m ³ /s	136	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.59	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1039922.48	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1345.42	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	5.07	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	323.61	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	335.05	From Attachment IV, p. 13
Air Density (D_a), kg/m ³	1.0516	From Attachment VII, p. 8
Air Thermal Conductivity (k), W/m°K	0.0289	From Attachment VII, p. 8
Air Specific Heat (c_p), J/kg°K	1008	From Attachment VII, p. 8
Air Dynamic Viscosity (ν_d), kg/ms	0.000020066	From Attachment VII, p. 8
Air Prandtl Number (P_r), dimensionless	0.7	From Attachment VII, p. 8
Air Flow Rate (Q), m ³ /s	119	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.26	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	908434.40	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1207.51	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	4.55	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	323.23	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

Input Parameter	Value	Source
Constant (ρ_i), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	334.58	From Attachment IV, p. 14
Air Density (D_a), kg/m ³	1.0533	From Attachment VII, p. 4
Air Thermal Conductivity (k), W/m°K	0.02886	From Attachment VII, p. 4
Air Specific Heat (c_p), J/kg°K	1008	From Attachment VII, p. 4
Air Dynamic Viscosity (ν_d), kg/ms	0.000020044	From Attachment VII, p. 4
Air Prandtl Number (P_r), dimensionless	0.7	From Attachment VII, p. 4
Air Flow Rate (Q), m ³ /s	85	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.62	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	652947.21	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	927.17	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	3.49	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	322.23	Equation 11e, Section 5.3

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer Calculation for the Exhaust Shaft Connectors

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From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	408.3	From Section 5.4
Perimeter (P), m	27.42	From Section 5.4
Hydraulic Diameter (D_h), m	7.67	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	11195.59	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	52.58	From Section 5.4
Intake Air Temperature (T_{airin}), °K	334.81	From Attachment IV, p. 14
Air Density (D_a), kg/m ³	1.0525	From Attachment VII, p. 6
Air Thermal Conductivity (k), W/m°K	0.02888	From Attachment VII, p. 6
Air Specific Heat (c_p), J/kg°K	1008	From Attachment VII, p. 6
Air Dynamic Viscosity (ν_d), kg/ms	0.000020055	From Attachment VII, p. 6
Air Prandtl Number (P_r), dimensionless	0.7	From Attachment VII, p. 6
Air Flow Rate (Q), m ³ /s	102	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.94	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	780901.99	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1069.88	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	4.03	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	299.88	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	299.88	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	322.76	Equation 11e, Section 5.3

ATTACHMENT VI

HEAT TRANSFER CALCULATION FOR EXHAUST SHAFTS

This attachment calculates the change in temperature, based on the heat transfer for various airflow quantities and due to autocompression, in the exhaust shafts.

ATTACHMENT VI

Air Temperature from Emplacement Drifts °C 43
 Estimated Airflow per Emplacement Split, m³/s 1
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P=\pi \times \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P \times \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4 \times (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	306.63	From Attachment V, p. 2
Air Density (D_a), kg/m ³	1.1536	From Attachment VII, p. 3
Air Thermal Conductivity (k), W/m°K	0.02674	From Attachment VII, p. 3
Air Specific Heat (c_p), J/kg°K	1006.1	From Attachment VII, p. 3
Air Dynamic Viscosity (ν_d), kg/ms	1.8765E-05	From Attachment VII, p. 3
Air Prandtl Number (P_r), dimensionless	0.707	From Attachment VII, p. 3
Air Flow Rate (Q), m ³ /s	34	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.79	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	359389.59	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	576.77	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	2.08	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rl}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rl} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	301.99	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (Texhaust), °K	297.67	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (Texhaust), °R	535.81	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	551.93	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	543.87	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 43
 Estimated Airflow per Emplacement Split, m³/s 4
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P=\pi \times \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P \times \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4 \times (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	308.22	From Attachment V, p. 2
Air Density (D_a), kg/m ³	1.1479	From Attachment VII, p. 5
Air Thermal Conductivity (k), W/m°K	0.02686	From Attachment VII, p. 5
Air Specific Heat (c_p), J/kg°K	1006.2	From Attachment VII, p. 5
Air Dynamic Viscosity (ν_d), kg/ms	1.8838E-05	From Attachment VII, p. 5
Air Prandtl Number (P_r), dimensionless	0.706	From Attachment VII, p. 5
Air Flow Rate (Q), m ³ /s	136	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.16	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1424912.07	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1735.40	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² K	6.30	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rl}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rl} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	303.95	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (Texhaust), °K	299.63	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (Texhaust), °R	539.33	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	554.8	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	547.07	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 43 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 5 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	308.46	From Attachment V, p. 3
Air Density (D_a), kg/m ³	1.147	From Attachment VII, p. 7
Air Thermal Conductivity (k), W/m°K	0.02688	From Attachment VII, p. 7
Air Specific Heat (c_p), J/kg°K	1006.3	From Attachment VII, p. 7
Air Dynamic Viscosity (ν_d), kg/ms	1.8849E-05	From Attachment VII, p. 7
Air Prandtl Number (P_f), dimensionless	0.706	From Attachment VII, p. 7
Air Flow Rate (Q), m ³ /s	170	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.95	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1778704.97	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2072.30	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	7.53	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	304.26	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	299.94	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	539.89	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	555.23	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	547.56	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 43 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 6 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	308.66	From Attachment V, p. 3
Air Density (D_a), kg/m ³	1.1463	From Attachment VII, p. 9
Air Thermal Conductivity (k), W/m°K	0.0269	From Attachment VII, p. 9
Air Specific Heat (c_p), J/kg°K	1006.3	From Attachment VII, p. 9
Air Dynamic Viscosity (ν_d), kg/ms	1.8858E-05	From Attachment VII, p. 9
Air Prandtl Number (P_f), dimensionless	0.706	From Attachment VII, p. 9
Air Flow Rate (Q), m ³ /s	204	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	4.74	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2132125.29	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2395.63	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	8.71	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	304.52	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	300.20	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	540.36	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	555.59	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	547.98	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

43
 7

From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P=\pi \cdot \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P \cdot \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4 \cdot (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	308.84	From Attachment V, p. 4
Air Density (D_a), kg/m ³	1.1457	From Attachment VII, p. 11
Air Thermal Conductivity (k), W/m°K	0.02691	From Attachment VII, p. 11
Air Specific Heat (c_p), J/kg°K	1006.3	From Attachment VII, p. 11
Air Dynamic Viscosity (ν_d), kg/ms	1.8867E-05	From Attachment VII, p. 11
Air Prandtl Number (P_r), dimensionless	0.706	From Attachment VII, p. 11
Air Flow Rate (Q), m ³ /s	238	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	5.53	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2484991.54	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2707.88	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	9.85	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	304.75	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	300.43	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	540.77	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	555.91	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	548.34	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

47
 4

From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P=\pi \cdot \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P \cdot \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A=\pi/4 \cdot (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	309.86	From Attachment V, p. 5
Air Density (D_a), kg/m ³	1.142	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02699	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1006.4	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	1.8913E-05	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.706	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	136	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.16	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1411966.80	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1722.78	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	6.28	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	305.01	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	300.69	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	541.24	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	557.75	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	549.5	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C	47	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	2	Estimated, see Section 5.3.6
Heat Transfer and Average Temperature Calculations for the Exhaust Shaft		
Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	309.18	From Attachment V, p. 5
Air Density (D_a), kg/m ³	1.1445	From Attachment VII, p. 5
Air Thermal Conductivity (k), W/m°K	0.02694	From Attachment VII, p. 5
Air Specific Heat (c_p), J/kg°K	1006.3	From Attachment VII, p. 5
Air Dynamic Viscosity (ν_d), kg/ms	1.8882E-05	From Attachment VII, p. 5
Air Prandtl Number (P_f), dimensionless	0.706	From Attachment VII, p. 5
Air Flow Rate (Q), m ³ /s	68	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.58	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	708690.50	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	992.51	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.61	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	304.02	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	299.70	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	539.46	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	556.52	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	547.99	$(T_{exhaust} + T_{airin})/2$
Air Temperature from Emplacement Drifts °C	47	From Assumption 3.5
Estimated Airflow per Emplacement Split, m ³ /s	1	Estimated, see Section 5.3.6
Heat Transfer and Average Temperature Calculations for the Exhaust Shaft		
Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	308.21	From Attachment V, p. 4
Air Density (D_a), kg/m ³	1.1479	From Attachment VII, p. 3
Air Thermal Conductivity (k), W/m°K	0.02686	From Attachment VII, p. 3
Air Specific Heat (c_p), J/kg°K	1006.2	From Attachment VII, p. 3
Air Dynamic Viscosity (ν_d), kg/ms	1.8838E-05	From Attachment VII, p. 3
Air Prandtl Number (P_f), dimensionless	0.706	From Attachment VII, p. 3
Air Flow Rate (Q), m ³ /s	34	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	0.79	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	356228.02	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	572.47	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	2.08	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	302.87	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	298.55	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	537.39	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	554.78	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	546.09	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

47

5

From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	310.54	From Attachment V, p. 6
Air Density (D_a), kg/m ³	1.1396	From Attachment VII, p. 7
Air Thermal Conductivity (k), W/m°K	0.02704	From Attachment VII, p. 7
Air Specific Heat (c_p), J/kg°K	1006.4	From Attachment VII, p. 7
Air Dynamic Viscosity (ν_d), kg/ms	1.8944E-05	From Attachment VII, p. 7
Air Prandtl Number (P_f), dimensionless	0.706	From Attachment VII, p. 7
Air Flow Rate (Q), m ³ /s	170	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.95	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1758367.19	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2053.32	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	7.50	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	305.64	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	301.32	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	542.38	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	558.97	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	550.68	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C
 Estimated Airflow per Emplacement Split, m³/s
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

47

6

From Assumption 3.5
 Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	310.79	From Attachment V, p. 6
Air Density (D_a), kg/m ³	1.1387	From Attachment VII, p. 9
Air Thermal Conductivity (k), W/m°K	0.02706	From Attachment VII, p. 9
Air Specific Heat (c_p), J/kg°K	1006.4	From Attachment VII, p. 9
Air Dynamic Viscosity (ν_d), kg/ms	1.8956E-05	From Attachment VII, p. 9
Air Prandtl Number (P_f), dimensionless	0.706	From Attachment VII, p. 9
Air Flow Rate (Q), m ³ /s	204	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	4.74	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2107039.52	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2373.05	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	8.68	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	305.95	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	301.63	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	542.93	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	559.42	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	551.18	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C	47	From Assumption 3.5
Estimated Airflow per Emplacement Split, m³/s	7	Estimated, see Section 5.3.6
Heat Transfer and Average Temperature Calculations for the Exhaust Shaft		
Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P=\pi \cdot \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m²	10425.3	$A_s = P \cdot \text{Drift Length}$
Cross Section Area (A), m²	43.01	$A=\pi/4 \cdot (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	311.01	From Attachment V, p. 7
Air Density (D_a), kg/m³	1.1379	From Attachment VII, p. 11
Air Thermal Conductivity (k), W/m°K	0.02707	From Attachment VII, p. 11
Air Specific Heat (c_p), J/kg°K	1006.4	From Attachment VII, p. 11
Air Dynamic Viscosity (ν_d), kg/ms	1.8966E-05	From Attachment VII, p. 11
Air Prandtl Number (P_r), dimensionless	0.706	From Attachment VII, p. 11
Air Flow Rate (Q), m³/s	238	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	5.53	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2455190.54	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2681.87	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m²°K	9.81	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	306.23	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (Texhaust), °K	301.91	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (Texhaust), °R	543.44	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	559.82	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	551.63	$(T_{exhaust} + T_{airin})/2$
Air Temperature from Emplacement Drifts °C	50	From Assumption 3.5
Estimated Airflow per Emplacement Split, m³/s	5	Estimated, see Section 5.3.6
Heat Transfer and Average Temperature Calculations for the Exhaust Shaft		
Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P=\pi \cdot \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m²	10425.3	$A_s = P \cdot \text{Drift Length}$
Cross Section Area (A), m²	43.01	$A=\pi/4 \cdot (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	312.08	From Attachment V, p. 8
Air Density (D_a), kg/m³	1.1341	From Attachment VII, p. 7
Air Thermal Conductivity (k), W/m°K	0.02716	From Attachment VII, p. 7
Air Specific Heat (c_p), J/kg°K	1006.5	From Attachment VII, p. 7
Air Dynamic Viscosity (ν_d), kg/ms	1.9015E-05	From Attachment VII, p. 7
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 7
Air Flow Rate (Q), m³/s	170	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.95	$v=Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1743346.99	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2038.41	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m²°K	7.48	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	306.66	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (Texhaust), °K	302.34	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (Texhaust), °R	544.21	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	561.74	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	552.98	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 50 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 3 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	311.24	From Attachment V, p. 9
Air Density (D_a), kg/m ³	1.1371	From Attachment VII, p. 5
Air Thermal Conductivity (k), W/m°K	0.02709	From Attachment VII, p. 5
Air Specific Heat (c_p), J/kg°K	1006.4	From Attachment VII, p. 5
Air Dynamic Viscosity (ν_d), kg/ms	1.8976E-05	From Attachment VII, p. 5
Air Prandtl Number (P_r), dimensionless	0.706	From Attachment VII, p. 5
Air Flow Rate (Q), m ³ /s	102	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.37	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1050930.64	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1360.28	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	4.98	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rl}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rl} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	305.65	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	301.33	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	542.39	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	560.23	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	551.31	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 50 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 2 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	310.51	From Attachment V, p. 7
Air Density (D_a), kg/m ³	1.1397	From Attachment VII, p. 3
Air Thermal Conductivity (k), W/m°K	0.02704	From Attachment VII, p. 3
Air Specific Heat (c_p), J/kg°K	1006.4	From Attachment VII, p. 3
Air Dynamic Viscosity (ν_d), kg/ms	1.8943E-05	From Attachment VII, p. 3
Air Prandtl Number (P_r), dimensionless	0.706	From Attachment VII, p. 3
Air Flow Rate (Q), m ³ /s	68	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	1.58	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	703445.73	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	986.63	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	3.61	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rl}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rl} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	304.82	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	300.50	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	540.9	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	558.92	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	549.91	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 50 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 6 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	312.38	From Attachment V, p. 8
Air Density (D_a), kg/m ³	1.133	From Attachment VII, p. 9
Air Thermal Conductivity (k), W/m°K	0.02718	From Attachment VII, p. 9
Air Specific Heat (c_p), J/kg°K	1006.5	From Attachment VII, p. 9
Air Dynamic Viscosity (ν_d), kg/ms	1.9029E-05	From Attachment VII, p. 9
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 9
Air Flow Rate (Q), m ³ /s	204	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	4.74	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2088449.63	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2355.29	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	8.65	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	307.02	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	302.70	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	544.86	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	562.28	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	553.57	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 50 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 7 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	312.63	From Attachment V, p. 9
Air Density (D_a), kg/m ³	1.1321	From Attachment VII, p. 11
Air Thermal Conductivity (k), W/m°K	0.0272	From Attachment VII, p. 11
Air Specific Heat (c_p), J/kg°K	1006.5	From Attachment VII, p. 11
Air Dynamic Viscosity (ν_d), kg/ms	1.9040E-05	From Attachment VII, p. 11
Air Prandtl Number (P_r), dimensionless	0.705	From Attachment VII, p. 11
Air Flow Rate (Q), m ³ /s	238	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	5.53	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2433182.57	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2661.49	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	9.78	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	307.33	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	303.01	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	545.42	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	562.73	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	554.08	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 60 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 5 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	317.2	From Attachment V, p. 11
Air Density (D_a), kg/m ³	1.1157	From Attachment VII, p. 7
Air Thermal Conductivity (k), W/m°K	0.02754	From Attachment VII, p. 7
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 7
Air Dynamic Viscosity (ν_d), kg/ms	1.9249E-05	From Attachment VII, p. 7
Air Prandtl Number (P_f), dimensionless	0.704	From Attachment VII, p. 7
Air Flow Rate (Q), m ³ /s	170	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.95	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1694213.26	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1991.47	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	7.41	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	310.02	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	305.70	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	550.26	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	570.96	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	560.61	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 60 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 6 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	317.61	From Attachment V, p. 12
Air Density (D_a), kg/m ³	1.1142	From Attachment VII, p. 9
Air Thermal Conductivity (k), W/m°K	0.02757	From Attachment VII, p. 9
Air Specific Heat (c_p), J/kg°K	1006.9	From Attachment VII, p. 9
Air Dynamic Viscosity (ν_d), kg/ms	1.9268E-05	From Attachment VII, p. 9
Air Prandtl Number (P_f), dimensionless	0.704	From Attachment VII, p. 9
Air Flow Rate (Q), m ³ /s	204	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	4.74	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2028320.49	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2299.90	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	8.57	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	310.51	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	306.19	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	551.14	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	571.7	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	561.42	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 60 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 3 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	316.01	From Attachment V, p. 11
Air Density (D_a), kg/m ³	1.12	From Attachment VII, p. 3
Air Thermal Conductivity (k), W/m°K	0.02745	From Attachment VII, p. 3
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 3
Air Dynamic Viscosity (ν_d), kg/ms	1.9195E-05	From Attachment VII, p. 3
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 3
Air Flow Rate (Q), m ³ /s	102	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	2.37	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1023316.49	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1330.48	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	4.94	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	308.64	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	304.32	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	547.78	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	568.82	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	558.3	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 60 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 4 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter})^2$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	316.7	From Attachment V, p. 10
Air Density (D_a), kg/m ³	1.1175	From Attachment VII, p. 5
Air Thermal Conductivity (k), W/m°K	0.02751	From Attachment VII, p. 5
Air Specific Heat (c_p), J/kg°K	1006.8	From Attachment VII, p. 5
Air Dynamic Viscosity (ν_d), kg/ms	1.9226E-05	From Attachment VII, p. 5
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 5
Air Flow Rate (Q), m ³ /s	136	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.16	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1359181.32	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1669.64	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	6.21	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	309.43	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	305.11	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	549.2	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	570.06	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	559.63	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 60 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 7 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	317.98	From Attachment V, p. 12
Air Density (D_a), kg/m ³	1.1129	From Attachment VII, p. 11
Air Thermal Conductivity (k), W/m°K	0.0276	From Attachment VII, p. 11
Air Specific Heat (c_p), J/kg°K	1006.9	From Attachment VII, p. 11
Air Dynamic Viscosity (ν_d), kg/ms	1.9285E-05	From Attachment VII, p. 11
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 11
Air Flow Rate (Q), m ³ /s	238	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	5.53	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2361529.36	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2597.49	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	9.69	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	310.94	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	306.62	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	551.92	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	572.36	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	562.14	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 60 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 8 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	318.26	From Attachment V, p. 10
Air Density (D_a), kg/m ³	1.1119	From Attachment VII, p. 13
Air Thermal Conductivity (k), W/m°K	0.02762	From Attachment VII, p. 13
Air Specific Heat (c_p), J/kg°K	1006.9	From Attachment VII, p. 13
Air Dynamic Viscosity (ν_d), kg/ms	0.000019298	From Attachment VII, p. 13
Air Prandtl Number (P_r), dimensionless	0.704	From Attachment VII, p. 13
Air Flow Rate (Q), m ³ /s	272	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	6.32	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2694649.14	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2886.70	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	10.77	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	311.29	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	306.97	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	552.55	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	572.87	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	562.71	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 70 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 4 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	321.58	From Attachment V, p. 13
Air Density (D_a), kg/m ³	1.1	From Attachment VII, p. 3
Air Thermal Conductivity (k), W/m°K	0.02788	From Attachment VII, p. 3
Air Specific Heat (c_p), J/kg°K	1007.1	From Attachment VII, p. 3
Air Dynamic Viscosity (ν_d), kg/ms	1.9450E-05	From Attachment VII, p. 3
Air Prandtl Number (P_r), dimensionless	0.703	From Attachment VII, p. 3
Air Flow Rate (Q), m ³ /s	136	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.16	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1322488.43	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1632.78	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	6.15	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	312.56	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	308.24	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	554.83	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	578.84	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_s), °R	566.84	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 70 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 7 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	323.23	From Attachment V, p. 14
Air Density (D_a), kg/m ³	1.0941	From Attachment VII, p. 9
Air Thermal Conductivity (k), W/m°K	0.028	From Attachment VII, p. 9
Air Specific Heat (c_p), J/kg°K	1007.2	From Attachment VII, p. 9
Air Dynamic Viscosity (ν_d), kg/ms	1.9525E-05	From Attachment VII, p. 9
Air Prandtl Number (P_r), dimensionless	0.703	From Attachment VII, p. 9
Air Flow Rate (Q), m ³ /s	238	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	5.53	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2293099.11	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2536.02	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	9.60	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	314.46	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	310.14	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	558.25	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	581.81	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_s), °R	570.03	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 70 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 6 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	322.76	From Attachment V, p. 15
Air Density (D_a), kg/m ³	1.0957	From Attachment VII, p. 7
Air Thermal Conductivity (k), W/m°K	0.02797	From Attachment VII, p. 7
Air Specific Heat (c_p), J/kg°K	1007.2	From Attachment VII, p. 7
Air Dynamic Viscosity (ν_d), kg/ms	1.9503E-05	From Attachment VII, p. 7
Air Prandtl Number (P_r), dimensionless	0.703	From Attachment VII, p. 7
Air Flow Rate (Q), m ³ /s	204	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	4.74	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1970608.28	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2246.44	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	8.49	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	313.92	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	309.60	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	557.28	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	580.97	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_s), °R	569.13	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C 70 From Assumption 3.5
 Estimated Airflow per Emplacement Split, m³/s 5 Estimated, see Section 5.3.6
 Heat Transfer and Average Temperature Calculations for the Exhaust Shaft

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	P=π*Diameter for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	322.23	From Attachment V, p. 14
Air Density (D_a), kg/m ³	1.0976	From Attachment VII, p. 5
Air Thermal Conductivity (k), W/m°K	0.02793	From Attachment VII, p. 5
Air Specific Heat (c_p), J/kg°K	1007.2	From Attachment VII, p. 5
Air Dynamic Viscosity (ν_d), kg/ms	1.9479E-05	From Attachment VII, p. 5
Air Prandtl Number (P_r), dimensionless	0.703	From Attachment VII, p. 5
Air Flow Rate (Q), m ³ /s	170	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	3.95	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	1647048.00	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	1946.16	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	7.35	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	313.30	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °K	308.98	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. (T _{exhaust}), °R	556.16	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	580.01	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_s), °R	568.09	$(T_{exhaust} + T_{airin})/2$

Air Temperature from Emplacement Drifts °C	70
Estimated Airflow per Emplacement Split, m ³ /s	8
Heat Transfer and Average Temperature Calculations for the Exhaust Shaft	

From Assumption 3.5
Estimated, see Section 5.3.6

Input Parameter	Value	Source
Constant (π), dimensionless	3.1416	Universal Constant
Drift Length, m	448.4	From Section 5.4
Drift Diameter, m	7.4	Diameter - 2 x Lining, Section 5.4
Perimeter (P), m	23.25	$P = \pi * \text{Diameter}$ for Circle, Section 5.4
Hydraulic Diameter (D_h), m	7.4	$D_h = 4A/P$, Section 5.3.2
Surface Area (A_s), m ²	10425.3	$A_s = P * \text{Drift Length}$
Cross Section Area (A), m ²	43.01	$A = \pi/4 * (\text{Diameter}^2)$ for Circle, Section 5.4
Intake Air Temperature (T_{airin}), °K	323.61	From Attachment V, p. 13
Air Density (D_e), kg/m ³	1.0927	From Attachment VII, p. 11
Air Thermal Conductivity (k), W/m°K	0.02803	From Attachment VII, p. 11
Air Specific Heat (c_p), J/kg°K	1007.3	From Attachment VII, p. 11
Air Dynamic Viscosity (V_d), kg/ms	1.9542E-05	From Attachment VII, p. 11
Air Prandtl Number (P_r), dimensionless	0.703	From Attachment VII, p. 11
Air Flow Rate (Q), m ³ /s	272	Airflow Estimate x 34, from Section 5.3.6
Air Flow Velocity (v), m/s	6.32	$v = Q/A$, Section 5.3.4
Reynolds Number (R_e), dimensionless	2615054.43	Equation 14, Section 5.3.4
Nusselt Number (N_u), dimensionless	2817.08	Equation 13, Section 5.3.3
Conv. Heat Transfer Coef. (h_c), W/m ² °K	10.67	Equation 12, Section 5.3.2
Rock Temp. at Top of Column (T_{rt}), °K	291.86	Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb}), °K	299.88	Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$), °K	295.87	$(T_{rt} + T_{rb})/2$
Outlet Air Temp. (T_{airout}), °K	314.92	Equation 11e, Section 5.3
Autocompression, °K	-4.32	Section 5.2.5
Exhaust Shaft Exhaust Temp. ($T_{exhaust}$), °K	310.60	$T_{airout} + \text{Autocompression}$, Section 5.2.4.2
Exhaust Shaft Exhaust Temp. ($T_{exhaust}$), °R	559.08	Converted with conversion factor from Section 5.5.
Intake Air Temperature (T_{airin}), °R	582.5	Converted with conversion factor from Section 5.5.
Exhaust Shaft Average Temp. (T_d), °R	570.79	$(T_{exhaust} + T_{airin})/2$

ATTACHMENT VII

LINEAR INTERPOLATION OF AIR PROPERTIES AND BAROMETRIC PRESSURE

This attachment calculates the air properties based on a linear interpolation for various temperatures and the barometric pressure based on a linear interpolation for various elevations.

ATTACHMENT VII

Formula for linear interpolation is:

$$X_{airin} = X_a + [(T_{airin} - T_a) / (T_b - T_a)] \times (X_b - X_a)$$

 X = Air Properties

Temperature ($^{\circ}\text{K}$), (from Attachment IV, p. IV-2) 312.03	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}\text{K}$	300	312.03	350
Air Density (D_a), kg/m^3	1.1774	1.1342	0.998
Air Thermal Conductivity (k), $\text{W/m}^{\circ}\text{K}$	0.02624	0.02715	0.03003
Air Specific Heat (c_p), $\text{J/kg}^{\circ}\text{K}$	1005.7	1006.5	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.901E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.705	0.697

Temperature ($^{\circ}\text{K}$), (from Attachment IV, p. IV-6) 314.96	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}\text{K}$	300	314.96	350
Air Density (D_a), kg/m^3	1.1774	1.1237	0.998
Air Thermal Conductivity (k), $\text{W/m}^{\circ}\text{K}$	0.02624	0.02737	0.03003
Air Specific Heat (c_p), $\text{J/kg}^{\circ}\text{K}$	1005.7	1006.7	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.915E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.705	0.697

Temperature ($^{\circ}\text{K}$), (from Attachment IV, p. IV-7) 317.8	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}\text{K}$	300	317.8	350
Air Density (D_a), kg/m^3	1.1774	1.1135	0.998
Air Thermal Conductivity (k), $\text{W/m}^{\circ}\text{K}$	0.02624	0.02759	0.03003
Air Specific Heat (c_p), $\text{J/kg}^{\circ}\text{K}$	1005.7	1006.9	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.928E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature ($^{\circ}\text{K}$), (from Attachment IV, p. IV-12) 325.98	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}\text{K}$	300	325.98	350
Air Density (D_a), kg/m^3	1.1774	1.0842	0.998
Air Thermal Conductivity (k), $\text{W/m}^{\circ}\text{K}$	0.02624	0.02821	0.03003
Air Specific Heat (c_p), $\text{J/kg}^{\circ}\text{K}$	1005.7	1007.4	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.965E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.702	0.697

Temperature ($^{\circ}\text{K}$), (from Attachment IV, p. IV-15) 334.2	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}\text{K}$	300	334.2	350
Air Density (D_a), kg/m^3	1.1774	1.0547	0.998
Air Thermal Conductivity (k), $\text{W/m}^{\circ}\text{K}$	0.02624	0.02883	0.03003
Air Specific Heat (c_p), $\text{J/kg}^{\circ}\text{K}$	1005.7	1008	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	2.003E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.7	0.697

Temperature (°K), (from Attachment V, p. V-2)	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
306.63			
Intake Air Temperature (T _{airin}), °K	300	306.63	350
Air Density (D _a), kg/m ³	1.1774	1.1536	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02674	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.1	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.8765E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.707	0.697

Temperature (°K), (from Attachment V, p. V-4)	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
308.21			
Intake Air Temperature (T _{airin}), °K	300	308.21	350
Air Density (D _a), kg/m ³	1.1774	1.1479	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02686	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.2	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.8838E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.706	0.697

Temperature (°K), (from Attachment V, p. V-7)	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
310.51			
Intake Air Temperature (T _{airin}), °K	300	310.51	350
Air Density (D _a), kg/m ³	1.1774	1.1397	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02704	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.4	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.8943E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.706	0.697

Temperature (°K), (from Attachment V, p. V-11)	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
316.01			
Intake Air Temperature (T _{airin}), °K	300	316.01	350
Air Density (D _a), kg/m ³	1.1774	1.12	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02745	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.8	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.9195E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Attachment V, p. V-13)	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
321.58			
Intake Air Temperature (T _{airin}), °K	300	321.58	350
Air Density (D _a), kg/m ³	1.1774	1.1	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02788	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1007.1	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.9450E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.703	0.697

Temperature (°K), (from Attachment IV, p. IV-2) 312.9	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	312.9	350
Air Density (D _a), kg/m ³	1.1774	1.1311	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02722	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.6	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.905E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.705	0.697

Temperature (°K), (from Attachment IV, p. IV-4) 315.5	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	315.5	350
Air Density (D _a), kg/m ³	1.1774	1.1218	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02741	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.7	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.917E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.705	0.697

Temperature (°K), (from Attachment IV, p. IV-8) 318.19	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	318.19	350
Air Density (D _a), kg/m ³	1.1774	1.1121	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02762	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.9	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.929E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Attachment IV, p. IV-11) 326.37	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	326.37	350
Air Density (D _a), kg/m ³	1.1774	1.0828	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02824	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1007.4	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.967E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.702	0.697

Temperature (°K), (from Attachment IV, p. IV-14) 334.58	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	334.58	350
Air Density (D _a), kg/m ³	1.1774	1.0533	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02886	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1008	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	2.004E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.7	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-2) 308.22	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	308.22	350
Air Density (D_a), kg/m ³	1.1774	1.1479	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02686	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.2	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8838E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-5) 309.18	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	309.18	350
Air Density (D_a), kg/m ³	1.1774	1.1445	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02694	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.3	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8882E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-9) 311.24	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	311.24	350
Air Density (D_a), kg/m ³	1.1774	1.1371	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02709	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.4	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8976E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-10) 316.7	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	316.7	350
Air Density (D_a), kg/m ³	1.1774	1.1175	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02751	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.8	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9226E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-14) 322.23	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	322.23	350
Air Density (D_a), kg/m ³	1.1774	1.0976	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02793	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1007.2	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9479E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.703	0.697

Temperature ($^{\circ}$ K), (from Attachment IV, p. IV-3) 313.03	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	313.03	350
Air Density (D_a), kg/m ³	1.1774	1.1306	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02723	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.6	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.906E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.705	0.697

Temperature ($^{\circ}$ K), (from Attachment IV, p. IV-5) 316.24	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	316.24	350
Air Density (D_a), kg/m ³	1.1774	1.1191	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02747	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.8	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.921E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature ($^{\circ}$ K), (from Attachment IV, p. IV-9) 318.65	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	318.65	350
Air Density (D_a), kg/m ³	1.1774	1.1105	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02765	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.9	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.932E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature ($^{\circ}$ K), (from Attachment IV, p. IV-11) 326.63	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	326.63	350
Air Density (D_a), kg/m ³	1.1774	1.0819	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02826	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1007.5	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.968E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.702	0.697

Temperature ($^{\circ}$ K), (from Attachment IV, p. IV-14) 334.81	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	334.81	350
Air Density (D_a), kg/m ³	1.1774	1.0525	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02888	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1008	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	2.006E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.7	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-3) 308.46	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	308.46	350
Air Density (D_a), kg/m ³	1.1774	1.147	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02688	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.3	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8849E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-6) 310.54	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	310.54	350
Air Density (D_a), kg/m ³	1.1774	1.1396	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02704	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.4	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8944E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-8) 312.08	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	312.08	350
Air Density (D_a), kg/m ³	1.1774	1.1341	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02716	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.5	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9015E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.705	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-11) 317.2	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	317.2	350
Air Density (D_a), kg/m ³	1.1774	1.1157	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02754	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.8	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9249E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-15) 322.76	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	322.76	350
Air Density (D_a), kg/m ³	1.1774	1.0957	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02797	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1007.2	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9503E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.703	0.697

Temperature (°K), (from Attachment IV, p. IV-3) 313.12	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	313.12	350
Air Density (D _a), kg/m ³	1.1774	1.1303	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02723	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.6	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.906E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.705	0.697

Temperature (°K), (from Attachment IV, p. IV-5) 316.36	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	316.36	350
Air Density (D _a), kg/m ³	1.1774	1.1187	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02748	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.8	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.921E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Attachment IV, p. IV-8) 318.78	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	318.78	350
Air Density (D _a), kg/m ³	1.1774	1.11	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02766	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.9	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.932E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Attachment IV, p. IV-10) 326.82	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	326.82	350
Air Density (D _a), kg/m ³	1.1774	1.0812	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02827	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1007.5	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.969E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.702	0.697

Temperature (°K), (from Attachment IV, p. IV-13) 335.05	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
Intake Air Temperature (T _{airin}), °K	300	335.05	350
Air Density (D _a), kg/m ³	1.1774	1.0516	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.0289	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1008	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	2.007E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.7	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-3) 308.66	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	308.66	350
Air Density (D_a), kg/m ³	1.1774	1.1463	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.0269	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.3	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8858E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-6) 310.79	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	310.79	350
Air Density (D_a), kg/m ³	1.1774	1.1387	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02706	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.4	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8956E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-8) 312.38	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	312.38	350
Air Density (D_a), kg/m ³	1.1774	1.133	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02718	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.5	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9029E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.705	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-12) 317.61	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	317.61	350
Air Density (D_a), kg/m ³	1.1774	1.1142	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02757	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.9	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9268E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-14) 323.23	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	323.23	350
Air Density (D_a), kg/m ³	1.1774	1.0941	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.028	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1007.2	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9525E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.703	0.697

Temperature (°K), (from Attachment IV, p. IV-4) 313.21	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	313.21	350
Air Density (D_a), kg/m ³	1.1774	1.13	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02724	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1006.6	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.907E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.705	0.697

Temperature (°K), (from Attachment IV, p. IV-6) 316.47	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	316.47	350
Air Density (D_a), kg/m ³	1.1774	1.1183	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02749	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1006.8	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.922E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Attachment IV, p. IV-9) 318.91	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	318.91	350
Air Density (D_a), kg/m ³	1.1774	1.1096	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02767	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1006.9	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.933E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Attachment IV, p. IV-10) 327.01	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	327.01	350
Air Density (D_a), kg/m ³	1.1774	1.0805	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02829	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1007.5	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.97E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.702	0.697

Temperature (°K), (from Attachment IV, p. IV-13) 335.26	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	335.26	350
Air Density (D_a), kg/m ³	1.1774	1.0509	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02891	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1008	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	2.008E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.7	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-4) 308.84	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	308.84	350
Air Density (D_a), kg/m ³	1.1774	1.1457	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02691	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.3	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8867E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-7) 311.01	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	311.01	350
Air Density (D_a), kg/m ³	1.1774	1.1379	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02707	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.4	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.8966E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.706	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-9) 312.63	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	312.63	350
Air Density (D_a), kg/m ³	1.1774	1.1321	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.0272	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.5	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9040E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.705	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-12) 317.98	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	317.98	350
Air Density (D_a), kg/m ³	1.1774	1.1129	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.0276	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1006.9	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9285E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature ($^{\circ}$ K), (from Attachment V, p. V-13) 323.61	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	323.61	350
Air Density (D_a), kg/m ³	1.1774	1.0927	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02803	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1007.3	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.9542E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.703	0.697

Temperature (°K), (from Attachment IV, p. IV-12) 327.16	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	327.16	350
Air Density (D_e), kg/m ³	1.1774	1.0799	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.0283	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1007.5	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.971E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.702	0.697

Temperature (°K), (from Assumption 3.5) 316.16	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	316.16	350
Air Density (D_e), kg/m ³	1.1774	1.1194	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02746	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1006.8	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.92E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Assumption 3.5) 320.16	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	320.16	350
Air Density (D_e), kg/m ³	1.1774	1.1051	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02777	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1007	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.939E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Assumption 3.5) 323.16	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	323.16	350
Air Density (D_e), kg/m ³	1.1774	1.0943	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.028	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1007.2	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.952E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.703	0.697

Temperature (°K), (from Assumption 3.5) 333.16	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), °K	300	333.16	350
Air Density (D_e), kg/m ³	1.1774	1.0584	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02875	0.03003
Air Specific Heat (c_p), J/kg°K	1005.7	1007.9	1009
Air Dynamic Viscosity (V_d), kg/ms	1.8462E-05	1.998E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.701	0.697

Temperature (°K), (from Section 5.2.4.1)	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
288.86	250	288.86	300
Intake Air Temperature (T _{airin}), °K			
Air Density (D _e), kg/m ³	1.4128	1.2298	1.1774
Air Thermal Conductivity (k), W/m°K	0.02227	0.0254	0.02624
Air Specific Heat (c _p), J/kg°K	1005.3	1005.6	1005.7
Air Dynamic Viscosity (V _d), kg/ms	1.5990E-05	1.7911E-05	1.8462E-05
Air Prandtl Number (P _r), dimensionless	0.722	0.711	0.708

Temperature (°K), (from Attachment IV, p. IV-7)	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
316.08	300	316.08	350
Intake Air Temperature (T _{airin}), °K			
Air Density (D _e), kg/m ³	1.1774	1.1197	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02746	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.8	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.9198E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Attachment V, p. V-5)	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
309.86	300	309.86	350
Intake Air Temperature (T _{airin}), °K			
Air Density (D _e), kg/m ³	1.1774	1.142	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02699	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.4	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.8913E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.706	0.697

Temperature (°K), (from Attachment V, p. V-10)	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
318.26	300	318.26	350
Intake Air Temperature (T _{airin}), °K			
Air Density (D _e), kg/m ³	1.1774	1.1119	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02762	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1006.9	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.93E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.704	0.697

Temperature (°K), (from Section 5.2.4.1)	Input for X _a Sec 5.3.5	Interpolated Air Properties (X _{airin})	Input for X _b Sec 5.3.5
300.26	300	300.26	350
Intake Air Temperature (T _{airin}), °K			
Air Density (D _e), kg/m ³	1.1774	1.1765	0.998
Air Thermal Conductivity (k), W/m°K	0.02624	0.02626	0.03003
Air Specific Heat (c _p), J/kg°K	1005.7	1005.7	1009
Air Dynamic Viscosity (V _d), kg/ms	1.8462E-05	1.847E-05	2.0750E-05
Air Prandtl Number (P _r), dimensionless	0.708	0.708	0.697

Temperature ($^{\circ}$ K), (from Assumption 3.5) 343.16	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	300	343.16	350
Air Density (D_a), kg/m ³	1.1774	1.0225	0.998
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02624	0.02951	0.03003
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.7	1008.5	1009
Air Dynamic Viscosity (ν_d), kg/ms	1.8462E-05	2.044E-05	2.0750E-05
Air Prandtl Number (P_r), dimensionless	0.708	0.699	0.697

Temperature ($^{\circ}$ K), (from Section 5.2.4.1) 278.76	Input for X_a Sec 5.3.5	Interpolated Air Properties (X_{airin})	Input for X_b Sec 5.3.5
Intake Air Temperature (T_{airin}), $^{\circ}$ K	250	278.76	300
Air Density (D_a), kg/m ³	1.4128	1.2774	1.1774
Air Thermal Conductivity (k), W/m $^{\circ}$ K	0.02227	0.0246	0.02624
Air Specific Heat (c_p), J/kg $^{\circ}$ K	1005.3	1005.5	1005.7
Air Dynamic Viscosity (ν_d), kg/ms	1.5990E-05	1.7412E-05	1.8462E-05
Air Prandtl Number (P_r), dimensionless	0.722	0.714	0.708

Average Elevation (from Section 5.2) 3374.31	Input for X_a Sec 5.2.2	Interpolated Pressure (X_{ave})	Input for X_b Sec 5.2.2
Elevation	3000	3374.31	3500
Barometric Pressure (p_b), in. Hg	26.81	26.44	26.32

Average Elevation (from Section 5.2) 4740.76	Input for X_a Sec 5.2.2	Interpolated Pressure (X_{ave})	Input for X_b Sec 5.2.2
Elevation	4500	4740.76	5000
Barometric Pressure (p_b), in. Hg	25.36	25.13	24.89

Average Elevation (from Section 5.2) 4056.71	Input for X_a Sec 5.2.2	Interpolated Pressure (X_{ave})	Input for X_b Sec 5.2.2
Elevation	4000	4056.71	4500
Barometric Pressure (p_b), in. Hg	25.84	25.79	25.36

Average Elevation (from Section 5.2) 4058.35	Input for X_a Sec 5.2.2	Interpolated Pressure (X_{ave})	Input for X_b Sec 5.2.2
Elevation	4000	4058.35	4500
Barometric Pressure (p_b), in. Hg	25.84	25.78	25.36

Formula for linear interpolation is: $X_{ave} = X_a + [(El_{ave} - El_a) / (El_b - El_a)] \times (X_b - X_a)$
 X = Barometric Pressure

ATTACHMENT VIII
SAMPLE HAND CALCULATIONS

This attachment contains sample hand calculations of calculations from Attachment III, IV, V, VI, and VII

ATTACHMENT VIII

This is the sample calculation of linear interpolation for barometric pressure at elevation 3374.31 ft from Attachment VII p. VII-14. This calculation will be similar to all the barometric pressure calculations in Attachment VII.

$$\begin{aligned}\text{Elevation A (El}_a\text{)} &= 3000 \text{ ft from Attachment VII p. VII-14} \\ \text{Barometric Pressure A (X}_a\text{)} &= 26.81 \text{ in. Hg from Attachment VII p. VII-14}\end{aligned}$$

$$\begin{aligned}\text{Elevation B (El}_b\text{)} &= 3500 \text{ ft from Attachment VII p. VII-14} \\ \text{Barometric Pressure B (X}_b\text{)} &= 26.32 \text{ in. Hg from Attachment VII p. VII-14}\end{aligned}$$

$$\text{Elevation Average (El}_{ave}\text{)} = 3374.31 \text{ ft from Attachment VII p. VII-14}$$

$$\begin{aligned}X_{ave} &= X_a + [(El_{ave} - El_a) / (El_b - El_a)] \times (X_b - X_a) \text{ from Attachment VII p. VII-14} \\ X_{ave} &= 26.81 + [(3374.31 - 3000) / (3500 - 3000)] \times (26.32 - 26.81) \\ X_{ave} &= 26.81 + (374.31 / 500 \times -0.49) \\ X_{ave} &= 26.81 + (-0.37) \\ X_{ave} &= 26.44 \text{ in. Hg}\end{aligned}$$

This is the sample calculation of linear interpolation for air density at temperature 312.03 °K from Attachment VII p. VII-2. This calculation will be similar to all the air properties (air density, air thermal conductivity, air specific heat, air dynamic viscosity, air Prandtl number) calculations in Attachment VII.

$$\begin{aligned}\text{Temperature (T}_a\text{)} &= 300 \text{ °K from Attachment VII p. VII-2} \\ \text{Air Density (X}_a\text{)} &= 1.1774 \text{ kg/m}^3 \text{ from Attachment VII p. VII-2}\end{aligned}$$

$$\begin{aligned}\text{Temperature (T}_b\text{)} &= 350 \text{ °K from Attachment VII p. VII-2} \\ \text{Air Density (X}_b\text{)} &= 0.998 \text{ kg/m}^3 \text{ from Attachment VII p. VII-2}\end{aligned}$$

$$\text{Temperature (T}_{airin}\text{)} = 312.03 \text{ °K from Attachment VII p. VII-2}$$

$$\begin{aligned}X_{airin} &= X_a + [(T_{airin} - T_a) / (T_b - T_a)] \times (X_b - X_a) \text{ from Attachment VII p. VII-2} \\ X_{airin} &= 1.1774 + [(312.03 - 300) / (350 - 300)] \times (0.998 - 1.1774) \\ X_{airin} &= 1.1774 + (12.03 / 50) \times (-0.1794) \\ X_{airin} &= 1.1774 + (-0.0432) \\ X_{airin} &= 1.1342 \text{ kg/m}^3\end{aligned}$$

This is the sample calculation of heat transfer and average temperature for the intake shaft based on a surface air temperature of 5.6 °C and an estimated airflow per emplacement split of 8 m³/s from Attachment III p. III-2. This calculation will be similar to all the heat transfer calculations in Attachments III, IV, V, and VI.

$$\begin{aligned}\text{Surface Air Temperature} &= 5.6 \text{ °C from Section 5.2.4.1} \\ \text{Intake Air Temperature (T}_{airin}\text{)} &= 278.76 \text{ °K from Section 5.2.4.1}\end{aligned}$$

Air Density (D_e)	$= 1.2774 \text{ kg/m}^3$ from Attachment VII, p. 14
Air Thermal Conductivity (k)	$= 0.02455 \text{ W/m}^\circ\text{K}$ from Attachment VII, p. 14
Air Specific Heat (c_p)	$= 1005.5 \text{ J/kg}^\circ\text{K}$ from Attachment VII, p. 14
Air Dynamic Viscosity (V_d)	$= 1.7412\text{E-}05 \text{ kg/ms}$ from Attachment VII, p. 14
Air Prandtl Number (P_r)	$= 0.714$ dimensionless from Attachment VII, p. 14
Estimated Airflow per Emplacement Split	$= 8 \text{ m}^3/\text{s}$, estimated, see Section 5.3.6
Air Flow Rate (Q)	$= 8 \text{ m}^3/\text{s} \times 34$ splits, see Section 5.3.6
Air Flow Rate (Q)	$= 272 \text{ m}^3/\text{s}$
Constant (pi)	$= 3.1416$ dimensionless, universal constant
Drift Length	$= 386.4 \text{ m}$ from Section 5.4
Drift Diameter	$= \text{Diameter} - 2 \times \text{Lining}$, Section 5.4
Drift Diameter	$= 8.0 - 2 \times 0.3$
Drift Diameter	$= 7.4 \text{ m}$
Perimeter (P)	$= \pi \times \text{Diameter}$, m, Section 5.4
Perimeter (P)	$= 3.1416 \times 7.4$
Perimeter (P)	$= 23.25 \text{ m}$
Cross Section Area (A)	$= \pi/4 \times (\text{Diameter}^2)$, m^2 , Section 5.4
Cross Section Area (A)	$= 3.1416/4 \times (7.4^2)$
Cross Section Area (A)	$= 43.01 \text{ m}^2$
Hydraulic Diameter (D_h)	$= 4A/P$, m, Section 5.3.2
Hydraulic Diameter (D_h)	$= 4(43.01)/23.25$
Hydraulic Diameter (D_h)	$= 7.4 \text{ m}$
Surface Area (A_s)	$= P \times \text{Drift Length}$, m^2
Surface Area (A_s)	$= 23.25 \times 386.4$
Surface Area (A_s)	$= 8983.8 \text{ m}^2$
Air Flow Velocity (v)	$= Q/A$, m/s, Section 5.3.4
Air Flow Velocity (v)	$= 272/43.01$
Air Flow Velocity (v)	$= 6.32 \text{ m/s}$
Reynolds Number (R_e)	$= D_e v D_h / V_d$, dimensionless, Equation 14, Section 5.3.4
Reynolds Number (R_e)	$= 1.2774 \times 6.32 \times 7.4 / 1.7412\text{E-}05$
Reynolds Number (R_e)	$= 3431050.03$
Nusselt Number (N_u)	$= 0.023 R_e^{0.8} P_r^{0.4}$, dimensionless, Equation 13, Section 5.3.3
Nusselt Number (N_u)	$= 0.023 \times 3431050.03^{0.8} \times 0.714^{0.4}$
Nusselt Number (N_u)	$= 3400.55$
Conv. Heat Transfer Coef. (h_c)	$= k N_u / D_h$, $\text{W/m}^{20}\text{K}$, Equation 12, Section 5.3.2
Conv. Heat Transfer Coef. (h_c)	$= 0.02455 \times 3400.55 / 7.4$

$$\text{Conv. Heat Transfer Coef. } (h_c) = 11.28$$

Rock Temp. at Top of Column (T_{rt})	= 291.86 °K, Section 5.3.1
Rock Temp. at Bottom of Column (T_{rb})	= 299.12 °K, Section 5.3.1
Ave. Rock Temp. ($T_{rockave}$)	= $(T_{rt} + T_{rb})/2$
Ave. Rock Temp. ($T_{rockave}$)	= $(291.86 + 299.12)/2$
Ave. Rock Temp. ($T_{rockave}$)	= 295.49 °K

The outlet air temperature (T_{airout}) is calculated from equation 11e, section 5.3.

$$\begin{aligned} T_{airout} &= \frac{(h_c A_s / Q D_e c_p) T_{rockave} - (h_c A_s / 2 Q D_e c_p) T_{airin} + T_{airin}}{(1 + h_c A_s / 2 Q D_e c_p)} \\ T_{airout} &= \frac{(11.28 \times 8983.8 / 272 \times 1.2774 \times 1005.5) \times 295.49 - (11.28 \times 8983.8 / 2 \times 272 \times 1.2774 \times 1005.5) \times 278.76 + 278.76}{(1 + (11.28 \times 8983.8 / 2 \times 272 \times 1.2774 \times 1005.5))} \\ T_{airout} &= (85.71 - 40.43 + 278.76) / 1.145 \\ T_{airout} &= 283.00 °K \end{aligned}$$

$$\text{Autocompression} = 3.73 °K, \text{Section 5.2.5}$$

$$\begin{aligned} \text{Intake Shaft Exhaust Temperature } (T_{exhaust}) &= T_{airout} + \text{Autocompression, Section 5.2.4.1} \\ \text{Intake Shaft Exhaust Temperature } (T_{exhaust}) &= 283.00 + 3.73 \\ \text{Intake Shaft Exhaust Temperature } (T_{exhaust}) &= 286.73 °K \end{aligned}$$

$$\begin{aligned} \text{Intake Shaft Exhaust Temp. } (T_{exhaust}) \text{ converted to Rankine} &= 9/5 T_{exhaust} \text{ in Kelvin, Section 5.5} \\ \text{Intake Shaft Exhaust Temp. } (T_{exhaust}) \text{ converted to Rankine} &= 9/5 \times 286.73 \\ \text{Intake Shaft Exhaust Temp. } (T_{exhaust}) \text{ converted to Rankine} &= 516.11 °R \end{aligned}$$

$$\begin{aligned} \text{Intake Air Temperature } (T_{airin}) \text{ converted to Rankine} &= 9/5 T_{airin} \text{ in Kelvin, Section 5.5} \\ \text{Intake Air Temperature } (T_{airin}) \text{ converted to Rankine} &= 9/5 \times 278.76 \\ \text{Intake Air Temperature } (T_{airin}) \text{ converted to Rankine} &= 501.77 °R \end{aligned}$$

$$\begin{aligned} \text{Intake Shaft Average Temp. } (T_d) &= (T_{exhaust} + T_{airin})/2 \\ \text{Intake Shaft Average Temp. } (T_d) &= (516.11 + 501.77)/2 \\ \text{Intake Shaft Average Temp. } (T_d) &= 508.94 °R \end{aligned}$$

This is the sample calculation of specific weights of different columns of air at a surface air temperature of 5.6 °C, an emplacement drift exhaust air temperature of 43 °C and an estimated airflow per emplacement split of 6 m³/s from Attachment II p. II-2. This calculation will be similar to all the calculations in Attachments II.

Downcast Side

Height of Column Surface (L_o)	= 98.43 ft, from Section 5.2
Average Dry Bulb Temperature (T_d)	= 501.77 °R, from Section 5.2.4.1
Vapor Pressure (p_v)	= 0.07 in. Hg from Section 5.2.3
Barometric Pressure (p_b)	= 25.13 in. Hg from Attachment VII, p. VII-14

Specific Weight (W_o)	$= (1.325/T_d) \times (p_b - 0.378p_v)$, lb/ft 3 , Equation 6, Section 5.2.1
Specific Weight (W_o)	$= (1.325/509.14) \times (25.78 - 0.378 \times .07)$
Specific Weight (W_o)	$= 0.0662897$ lb/ft 3
Height of Column Surface (L_i)	$= 1266.38$ ft, from Section 5.2
Average Dry Bulb Temperature (T_d)	$= 509.14$ °R, from Attachment III, p. III-2
Vapor Pressure (p_v)	$= 0.07$ in. Hg from Section 5.2.3
Barometric Pressure (p_b)	$= 25.78$ in. Hg from Attachment VII, p. VII-14
Specific Weight (W_i)	$= (1.325/T_d) \times (p_b - 0.378p_v)$, lb/ft 3 , Equation 6, Section 5.2.1
Specific Weight (W_i)	$= (1.325/569.09) \times (26.44 - 0.378 \times .07)$
Specific Weight (W_i)	$= 0.0670217$ lb/ft 3
Height of Column Surface (L_r)	$= 101.71$ ft, from Section 5.2
Average Dry Bulb Temperature (T_d)	$= 569.09$ °R, from Section 5.2.4.1
Vapor Pressure (p_v)	$= 0.07$ in. Hg from Section 5.2.3
Barometric Pressure (p_b)	$= 26.44$ in. Hg from Attachment VII, p. VII-14
Specific Weight (W_r)	$= (1.325/T_d) \times (p_b - 0.378p_v)$, lb/ft 3 , Equation 6, Section 5.2.1
Specific Weight (W_r)	$= (1.325/569.09) \times (26.44 - 0.378 \times .07)$
Specific Weight (W_r)	$= 0.0614981$ lb/ft 3

Upcast Side

Height of Column Surface (L_e)	$= 1466.52$ ft, from Section 5.2
Average Dry Bulb Temperature (T_d)	$= 547.98$ °R, from Attachment VI, p. VI- 3
Vapor Pressure (p_v)	$= 0.07$ in. Hg from Section 5.2.3
Barometric Pressure (p_b)	$= 25.79$ in. Hg from Attachment VII, p. VII-14
Specific Weight (W_e)	$= (1.325/T_d) \times (p_b - 0.378p_v)$, lb/ft 3 , Equation 6, Section 5.2.1
Specific Weight (W_e)	$= (1.325/547.98) \times (25.79 - 0.378 \times .07)$
Specific Weight (W_e)	$= 0.0622955$ lb/ft 3

Head due to natural ventilation (h) is calculated from equation 2c, section 5.2

$$\begin{aligned}
 h &= (L_o W_o + L_i W_i + L_r W_r)/5.2 - L_e W_e/5.2, \text{ in. of water} \\
 h &= (98.43 \times 0.0662897 + 1266.38 \times 0.0670217 + 101.71 \times 0.0614981)/5.2 - 1466.52 \times \\
 &\quad 0.0622955/5.2 \\
 h &= 97.65/5.2 - 91.36/5.2 \\
 h &= 1.21 \text{ in. of water}
 \end{aligned}$$

$$\text{Resistance (r)} = 5.85E-12 \text{ in min}^2 / \text{ft}^6, \text{ from Attachment I, p. I-2}$$

$$\begin{aligned}
 \text{Airflow rate (Q)} &= (h/r)^{1/2}, \text{ ft}^3 / \text{min, Equation 1, Section 5.1} \\
 \text{Airflow rate (Q)} &= (1.21/5.85E-12)^{1/2} \\
 \text{Airflow rate (Q)} &= 454794.03 \text{ ft}^3 / \text{min}
 \end{aligned}$$

Airflow rate (Q) converted to m ³ /s	= Q in ft ³ / min / 2118.9, from Section 5.5
Airflow rate (Q) converted to m ³ /s	= 454794.03 / 2118.9
Airflow rate (Q) converted to m ³ /s	= 214.64 m ³ /s
Airflow rate (Q) per drift split	= Airflow Rate, in m ³ /s / Drift Splits from Section 5.3.6
Airflow rate (Q) per drift split	= 214.64 / 34
Airflow rate (Q) per drift split	= 6.31 m ³ /s